MAGNETOS and Ignition Principles

By C. S. Webster

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PREFACE

This book has been written in simple and concise language, especially for the beginner, or any one who desires to get a better understanding of the magneto, and the ignition system of the automobile. I have left out all unnecessary theory, and have only used that which is practical.

Although the low tension magneto has gone out of date, it will be well to know something of its operation. In fact, the low tension magneto system, when being operated with the switch on the battery, works exactly the same as do all the late battery systems. So if you get the fundamental principles of this system, you will know them all.

After this subject will come the high tension magneto, which is used on most all of the airplane, truck, and tractor motors. It is also used on many of the high priced cars.

In the latter part of this book, there are special instructions on the Bosch and Eisemann magnetos, which I am using by courtesy of the Bosch and Eisemann people.

Cedric S. Webster.

ELEMENTARY ELECTRICITY

No one knows just what electricity is, any more than that it is a form of energy which exists in everything. The earth is a vast reservoir of it, and we can neither manufacture nor destroy it. But we can set it in motion and make use of it by an electrical generator or dynamo.

Electricity, like water or air, will not move or flow without some kind of force or pressure to put it in motion.

Water can be set in motion by working a pump with any kind of power. Air can be set in motion by the use of a tire pump. You can hold your finger over the end of the tire pump, and can feel no pressure, but by working the handle up and down you can feel a pressure.

Now, electricity is set in motion by a magnetic force. Magnetism is always present where there is a current of electricity. And you all know that magnetism will attract certain kinds of metal.

MAGNETISM

Magnetism is a phenomenon of which we know very little, and cannot be insulated, it will go through any kind of material, even glass or rubber. However, we can control it by the use of a few simple rules. And it is so closely related to electricity that it might well be called electricity in another form.

If magnetism should cease to exist, for a few seconds, our electrical generators would be of no further use, as it is magnetism that sets the electricity in motion. With a magneto we have the permanent magnets to furnish our magnetic field. The later generators, such as are used on the cars of to-day, for charging the battery, etc., are of the electro-magnet type; but there is always enough magnetism retained in the field cores to start the generator going. This is called residual magnetism.

LAW OF MAGNETISM

Take a piece of soft iron or steel and wind an insulated wire around it, then send a current of electricity through the wire, and the core will become magnetized. One end will be a north pole, and the other a south pole. The lines of magnetic force will flow from north to south pole through the air. These lines of force are called the magnetic field. This kind of a magnet is called an electro-magnet, and will only be a magnet during the time a current of electricity is passed through the wire.

In winding an electro-magnet it is very important that you wind the wire in one direction, regardless of the number of layers. It may be wound either right or left hand, so long as all the layers of wire run in one direction.

If you hold an iron bar or core in your left hand, and wind an insulated wire around the core, in a left hand direction, then send a current through the wire in the same direction, the end you started on will be a south pole and the other end will be a north pole. Should you send a current through the wire in an opposite direction, the polarity of the magnet would be reversed. In other words, the north and south poles would change ends. You can also find the polarity with a compass. The end of the needle that points to the north pole of the earth, will point to the north pole of the magnet.

The strength of an electro-magnet is governed by the number of turns of wire, the strength of the current flowing, and the quality of the path through which the lines of force have to flow.

LAW OF INDUCTION

When a coil of wire is placed in a magnetic field and the strength of the field is varied, it will induce a current in the wire. Or if the magnetic field remains steady and the coil of wire is revolved, or moved rapidly in the magnetic field, it will induce a current of electricity in the wire.

This law of induction governs all coils, motors, and generators.

When an armature is revolved in a magnetic field it cuts the lines of force, which causes a current to flow in the armature winding, or winds as the case may be. Most of the authorities agree that the electricity is always in the wire, the same as air is always in a hollow tube, and the generator merely sets the electricity in motion, by cutting the magnetic lines of force.

ELECTRICITY CANNOT BE STORED

We do not store the electricity even in the storage battery, we store the electromotive force instead, which is called the E. M. F. If you put an ampemeter on each side of the storage battery, while it is being charged, you will find that there will be as much current come out of the negative side, as there is goes in the positive side. And when we use current, from the battery, to operate the starting motor, the current all returns back to the battery, so you can see that it is not consumed or used up by the starting motor. But it does lose its E. M. F. It is the E. M. F. that is stored and not the electricity. A battery that is said to be discharged, has just as much electricity as one that is fully charged. But before the electricity will flow it must be charged with an electromotive force. Let us liken the battery to a room with all the doors and windows closed: of course there is air in the room, but there must be a pressure before it will move, or before you will be aware of its presence. By opening a couple of doors or windows, when there is a breeze, you can feel its pressure.

All generators produce an alternating current, but the so called direct current generator, by the use of a commutator transforms the alternating into a direct current before it leaves the generator.

THE DIFFERENCE BETWEEN A PERMANENT AND ELECTRO-MAGNET

A permanent magnet is made of hard steel and retains its magnetism. An electro-magnet is made of soft iron, over which is wound an insulated wire, and when a current of electricity is passed through the wire, the core becomes magnetized, with a magnetic field surrounding the core. The instant the current stops flowing, the core will cease to be a magnet, and the core is said to demagnetize or die out. All magnetos, direct current generators, low voltage cut outs, and induction coils, work on the principle of an electro-magnet.

THE DIRECT CURRENT GENERATOR IS NOT ADAPTED TO IGNITION PURPOSES.

The D. C. generator will not produce a high enough voltage at low speed. But an A. C. generator, such as a magneto, will produce a high voltage at low speed, on account of the reversal of polarity every 180°, which causes a very rapid building up, and dying out of the armature core. This subject will be treated in a later chapter.

The high tension magneto is without a doubt the most efficient and reliable ignition on earth. For this reason it is used on most all of the aeroplane, truck, and tractor motors. It is also used on a great many of the high priced cars, such as the Pierce-Arrow, Locomobile, White, and many others.

THE LOW TENSION MAGNETO

The low tension magneto has one primary winding on the armature, and only puts out from 6 to 30 volts, therefore it must have a high tension induction coil in connection with it in order to "step up" the voltage, and make it sufficiently strong to jump the air gap at the spark plugs. This requires a voltage of 10,000 or more. It sometimes reaches near 30,000 volts. Taking all coils in consideration, the voltage would be anywhere from 12,000 to 25,000.

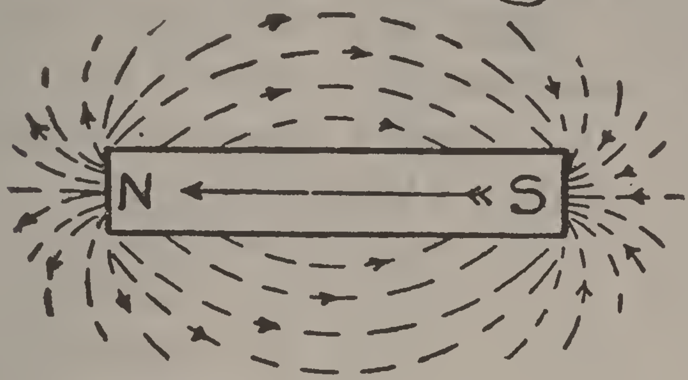
THE DIFFERENCE BETWEEN A HIGH AND LOW TENSION MAGNETO

A high tension magneto has two windings, therefore does not need a coil. It is complete within itself. This subject will be treated later.

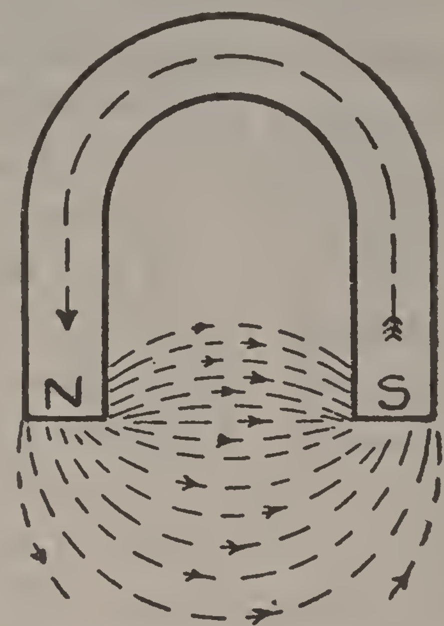
MAGNETO CONSISTS OF

A magneto consists principally of, a set of permanent magnets, two soft iron pole shoes, a non-magnetic base, armature, cam, breaker box, and distributor.

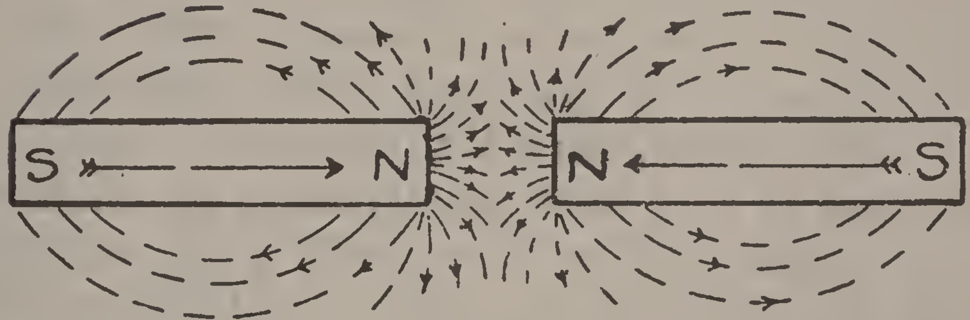
Fig. 1.



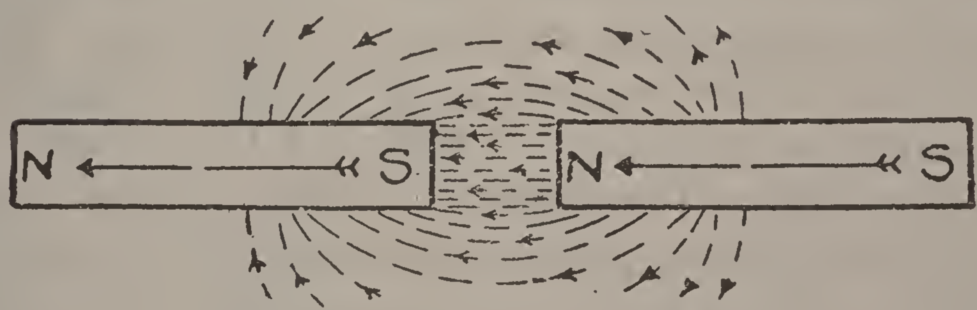
BAR MAGNET
AND
LINES OF FORCE



HORSESHOE MAGNET
AND
LINES OF FORCE



REPULSION OF TWO "LIKE" POLES



ATTRACTION OF TWO UN-LIKE" POLES

The magnets are called permanent magnets because they are made of hard steel and once they are magnetized they retain their magnetism almost indefinitely. Heat and vibration are the chief causes of magnets losing their strength. Were it not for the heat and vibration of the motor, the magnets would probably hold their strength for a good many years. All magnets have a north and south pole, and the lines of force always flow from north to south through the outside source, and from south to north through the magnets. These lines of force are called the magnetic field. See figure 1. Magnets are made in bar and horseshoe shapes. Where one magnet is placed over the other, it is called a compound magnet, but the single magnets, such as are used on the later high tension magnetos, are called simple magnets.

LIKE POLES OF MAGNETS REPEL AND UNLIKE POLES ATTRACT

When magnets are placed over the pole shoes, when assembling, be sure and have all north poles on one side and all south poles on the other: it makes no difference which side they are placed on, so long as all like poles are on the same side. It is not necessary for you to know which are the north or south poles; just put them together so they have no attraction for each other. The strength of a magnet can be tested with a magnetmeter, or by placing an iron bar across the two ends of the magnet, then take a small spring scale and put the hook in the center of the iron bar and pull steadily. Magnets should pull from 15 to 28 pounds, depending on the size of the magnet and the quality of the steel. See figure 5.

The function of the magnets is to create a magnetic field, in which the armature revolves. A soft iron bar called a "keeper" should be placed across the magnets as soon as they are removed from the magneto, to keep them from losing their strength.

A magneto will not give a good spark, no matter how well it is adjusted, if the magnets are weak. Magnets should always be recharged, when for any reason the magneto has been removed from the motor, where you have a charger at hand.

The pole shoes, or pole pieces are made of soft iron. They are placed inside of the magnets and form a semi-circle to fit the shape

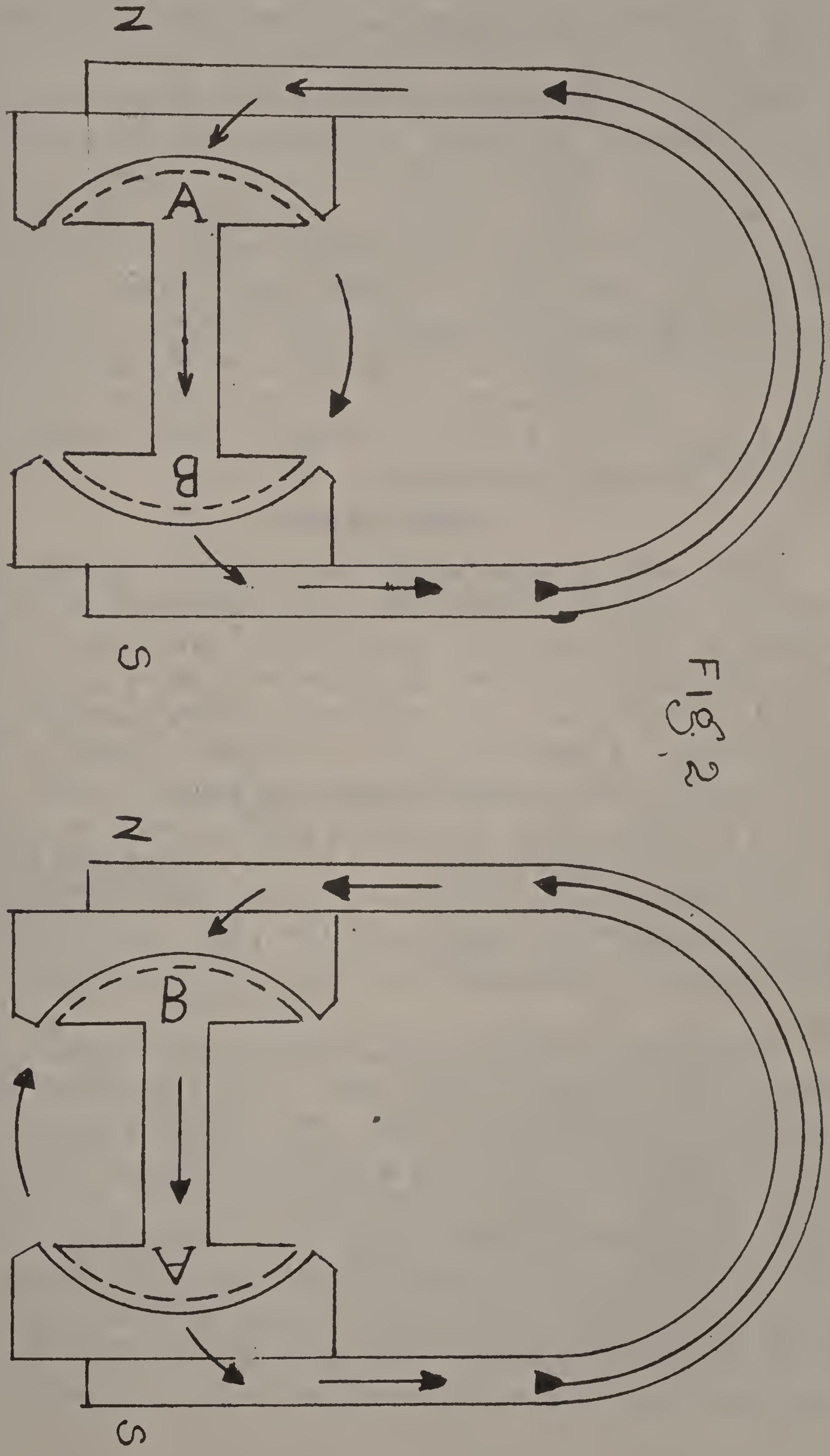


FIG. 2

DIRECTION OF FLOW OF MAGNETIC LINES OF FORCE of the armature. The armature revolves between the pole shoes and has a clearance of a few thousandths of an inch.

The base or bottom of a magneto is made of a non-magnetic material—usually aluminum or brass is used for this purpose. While these non-magnetic materials will not insulate magnetism, they do offer a high resistance; and as air offers 280 times resistance that the core of the armature does, it is evident that all the lines of force will go through the armature. Now as the armature revolves it will cut all the lines of force. This is how the magneto gets its pressure or voltage, to set the electricity in motion. If the base of the magneto were made of iron or steel, some of the lines of force would go through the base and its efficiency would be decreased considerably.

ARMATURES

There are three types of armature used on magnetos—shuttle, inductor, and rotor. The shuttle is the standard type and has the winding on the armature. All armatures are made of soft iron; that is the core is soft iron, the ends are made of a non- magnetic material. The core of all alternating current generators should be laminated. A laminated core is composed of sheets of soft iron, and insulated with a special varnish, and pressed tightly together. This is for the purpose of reducing eddy currents to a minimum, and giving a greater surface to flow of the magnetic flex. Eddy currents are induced electrical occurring when a solid metallic body is revolved in a magnetic field. Eddy currents consume a large amount of energy and often cause a harmful rise in temperature.

On this type of armature the lines of force reverse in direction through the armature every 180°, which would be each half revolution of the armature. We will mark the armature in order that you may understand this action more clearly. Mark one side A and the other side B. The lines of force flow from north to south through the armature going in at A and out at B. The last half revolution of the armature the side marked B would be where A was in the first half revolution. Then the lines of force would go in at B and out at A. This gives a reversal of the lines of force, each half turn of the armature, and the current generated in the armature winding will be alternating. See figure 2. Figure 4 shows the primary E. M. F. and how it raises from zero to maximum every 180°. You will also note that each half turn of the armature produces a current in an opposite direction.

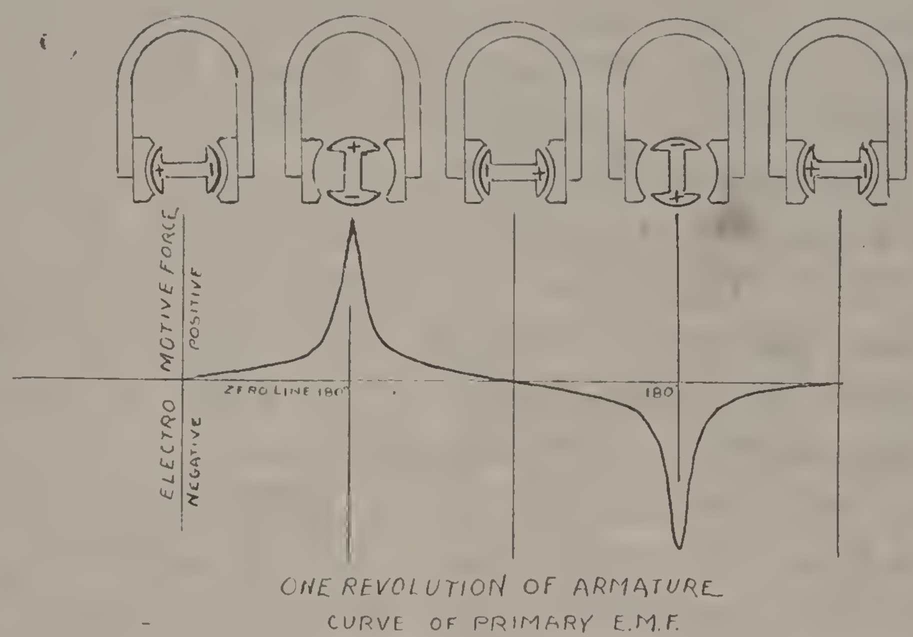


Figure 4

PRIMARY WINDING

The primary winding consists of a few turns of comparatively coarse insulated wire; one end is fastened to the core, which is called grounding it. The other end is called the live or insulated end. This type of armature gives two impulses in one revolution, one every 180°. See figure 4.

The inductor type armature is not used as extensively as the shuttle type, but is used on either high or low tension magnetos. On this type of armature the winding remains stationary and the inductors revolve. The winding surrounds the shaft between the inductors. The Remy inductor type gives two impulses to each revolution, the same as the shuttle type. While the high tension K W inductor type, is so arranged that it will give four current impulses to each revolution, by using a four-cornered cam.

The Dixie rotor type is a high tension magneto and will be treated later.

INTERRUPTER POINTS

The interrupter points are for the purpose of making and breaking the primary circuit. They are also called contact points or breaker points. They are usually made of platinum or tungsten. Platinum gives better results on a magneto than any other kind of material. The points are opened by a cam which is keyed to the armature shaft, and are closed by a spring. The spark occurs at the spark plugs the instant the points open. It would be impossible to get a spark if the points did not open, as the magnetic field would not vary. Therefore one should see to it that the points open and close properly, and that they open the proper distance, which is about one thirty-second of an inch, or from twenty-five to thirty thousandths. It is always better to adjust the points the distance recommended by the manufacturer of the particular magneto, as they have made many tests in order to arrive at their conclusion. It is sometimes possible to improve on their adjustments, but not as a rule. The adjustment can be made by using a magneto wrench of the proper size. First loosen the lock nut, then points can be turned one way or another to get proper adjustment. The points often become pitted and should be trued up with platinum file, or sand paper. It is very important that they should seat well. In other words, they should be made to touch the entire surface of the points, if possible. So great care should be taken in this adjustment.

Oil or grease should be kept away from the points, as either one will cause them to pit and burn badly, and would very likely cause the motor to miss, and it might stop entirely. Should such a thing happen, wash the points with gasoline. Where the points spark unusually bad when they are in proper adjustment, it would indicate that the condenser was not working properly, or that some of the connections were lose or broken. A sparking at the points, which is caused by poor condenser action, is a very bright and voluminous spark. When it is found necessary to replace the old condenser with a new one, you should use a condenser designed for the particular system, as all systems do not use the same sized condenser.

CONDENSER

A condenser is placed in the primary circuit and is connected to the two ends of the primary; it is also connected across the breaker points. In other words, it is shunted across the points. Its functions are to keep the breaker points from excessive sparking and to intensify the high tension spark. It is the high tension spark that goes to the spark plugs; and any system where the spark has to jump an air gap at the plugs, is called a jump spark system. Now all jump spark systems have a condenser. It may be placed anywhere in the electrical system, so long as it is connected across the breaker points, but the closer it is to both the points and the coil the better it will perform its work. It is the self-induced current caused by the dying out of the magnetic field, that goes into the condenser. This current is from 100 to 125 volts, and it is this current that causes the trouble at the breaker points, when the condenser is not working properly. Now when the breaker points open, the current goes into one side of the condenser instead of following up the points, which would cause a sparking, and would burn the points, and cause trouble. Owing to the fact that each side of the condenser is insulated from the other, the current cannot get through, so it immediately discharges back through the primary wire over the core of the coil which causes a very rapid dying out of the magnetic field, and remagnetizes the core in a reversed direction. It is this rapid dying out, and building up, of the magnetic field, which causes the high voltage. Without a condenser the magnetic fields would die out so slowly that the voltage would be too low to produce a good spark. Due to the back kick of the condenser there is a shower of sparks produced at one spark plug every time the points open once, but cannot be detected with the unaided eye.

A condenser is made of alternate layers of tinfoil and insulating material, either paraffined paper or mica. And if a current can get through a condenser it is short circuited and is no good. A condenser is capable of absorbing, or holding, a certain amount of electrical energy for a short time.

SECONDARY DISTRIBUTOR

A magneto, as well as all other ignition systems, has a secondary distributor. Its function is to distribute the high tension or high voltage current to the different spark plugs at the proper time. The most common type of distributor consists of a distributor gear, which carries a metal segment insulated with fiber, and a distributor plate or block which has carbon brushes that collect the secondary current and deliver it to the spark plugs. These carbon brushes have a small coil spring which presses them out against the revolving segment. If they do not make good contact with the segment, it may cause the motor to miss.

Before we take up the timing of a magneto (within itself) it must be understood that magnetos are not always driven in the same direction. Some motors drive a magneto right hand, which is called clockwise, while others drive it left hand, which is called anti-clockwise. A magneto can be timed to run either way. Of course they are timed correctly at the factory; but you might want to use it on a motor that would drive it in another direction from that which it was timed to run at the factory.

THE RULE FOR ADVANCING AND RETARDING OF SPARK

Advance is against the direction of rotation of the armature, and retard is with the rotation of the armature. To advance means to move the breaker box in the direction of rotation so that the points will open at an earlier period. Retard would be in the opposite direction, which would cause the points to open later.

RULES FOR TIMING MAGNETO WITHIN ITSELF

Pay no attention to marks on distributor or armature gear.

1. Breaker box **advanced.**

2. Points **just starting** to open.

3. Armature leaving pole shoe about one sixty-fourth of an inch.

4. Distributor segment making contact the **full width** of any one of the brushes. This rule applies to either clockwise or anti-clockwise timing. To time clockwise, start from the left pole shoe, looking from the driven end. To time anti-clockwise start from the right pole shoe.

HIGH TENSION INDUCTION COIL

The high tension coil, such as is used on all jump spark ignition systems, and also the one used with the low tension magneto, is composed of a soft iron core which is usually laminated. The core is sometimes made up of a bundle of soft iron wire, which has been put through an annealing process of softening, then each wire is insulated with a special varnish, then all put together and used as one core. The core is insulated, over which is wound a few layers of coarse primary wire, then several layers of insulating cloth, and it is then wound with many thousand turns of very fine wire which is called the secondary. It is insulated the entire length of the wire. And is then insulated between each layer with paraffined paper.

The induction coil just described is often referred to as a "step up coil" because the current that enters the coil is a very low voltage, and the current that comes out of it is a very high voltage. But the current that goes into the coil is not actually stepped up; because this current does not go to the secondary winding. This primary or low voltage current is only for the purpose of creating a magnetic field in the coil, and the dying out of the magnetic field causes a current to flow in the secondary winding. The current that leaves the battery or low tension magneto, never reaches the spark plugs on any system. The secondary or high tension current originates in the coil, and when it leaves the coil, it returns to the coil, as a current always returns to its source. The secondary and primary winding need not be connected together, and on some coils they are not.

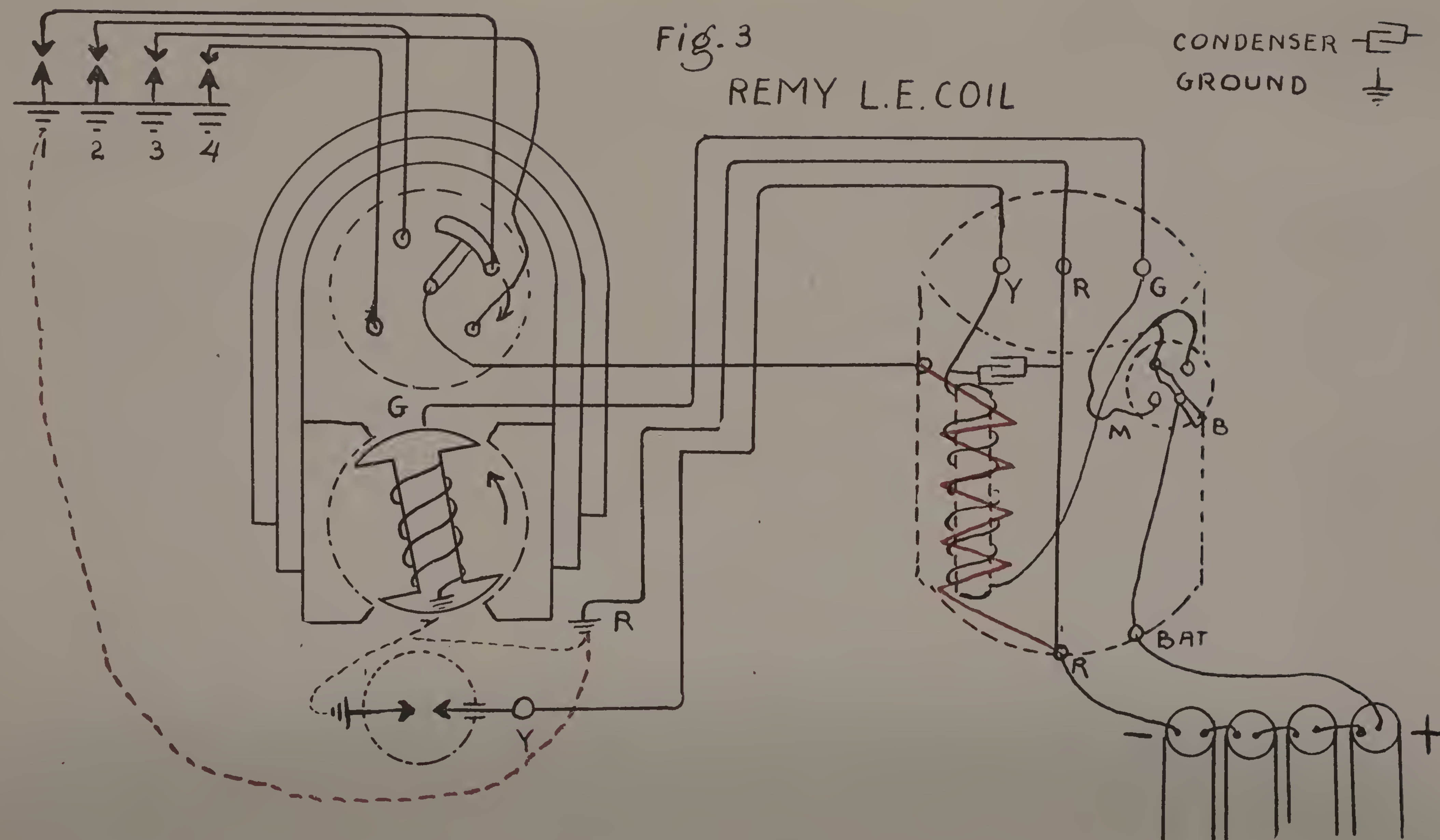
The coil just spoken of works on the dying out principle, while some work on the building up principle. Any change in the strength of the magnetic field will induce a current in the winding, or windings, as the case may be.

The voltage of an induction coil depends upon the strength of magnetic field, the number of turns of wire, and the rapidity with which it builds up or dies out. The voltage of an induction coil is anywhere from 12,000 to 25,000.

Figure 3 shows the internal wiring of a Remy L. E. coil, connected to a Remy magneto with the shuttle type armature. When running on the battery the current comes out of the terminal marked with a plus sign, which is the positive post of the battery, and goes across the switch through the primary wire, that is wound around the core of the coil, setting up a magnetic field in the coil and out the terminal Y, down to the insulated breaker point Y, and across the grounded breaker point through the ground, indicated by the dotted line, to the grounded terminal R, to the R terminal of the coil, out the R terminal at the bottom of the coil to the negative side of the battery, indicated by the minus sign, which completes the primary circuit.

Now the instant the breaker points open, the primary current ceases to flow, and the magnetic field of the coil dies out, which causes a current to flow in the secondary winding which winding is indicated by the red wire in the coil. It then goes to the center of the distributer, and is distributed by the revolving segment, to the different spark plugs in their proper firing order. In this case the revolving segment is in contact with the wire leading to number 1 spark plug, and the current will return through the ground of the engine, indicated by the dotted red line, and return through the primary wire R to the secondary winding in the coil, which completes the secondary circuit. When running on the battery the magneto is not putting out any current, because the magneto circuit is not complete. Now when the switch is turned on the magneto side, it completes the magneto circuit and interrupts the battery circuit.

The current will now flow from the armature wire G, which is called the magneto lead, to the G terminal on the coil, across the switch through the primary wire over the core, and out at Y to the insulated breaker Y, to the grounded breaker, through the ground to the grounded end of the armature winding, thus completing the magneto circuit. And when the breaker points open, the magneto circuit immediately stops flowing, which results in the dying out of the magnetic field and a current is said to be induced in the secondary winding, the same as when running on the battery. The current that leaves the secondary winding goes to the distributor and from there to some one of the spark plugs,



Y Insulated Breaker

The condenser in this system was placed in the magneto by the Remy People.

and returns through the ground to the primary wire R and from there to the red wire in the coil, which is the secondary winding.

Remember that the current that leaves the low tension magneto or battery, never goes to the spark plugs. The low tension or primary current is only for the purpose of magnetizing the soft iron core of the coil. The secondary current originates in the secondary winding, on all systems, whether the secondary winding is in the coil or magneto. The condenser on this Remy system just described was placed in the magneto by the Remy factory, but for convenience I have placed it in the coil, as it is on some of the other systems. It will work in either place so long as it is connected to the two primary wires that lead to the breaker points. See figure 3.

MAGNET CHARGING

Hold the magnet that is to be recharged at right angles to the charger, and at a distance of about 4 inches above the charger. Then turn the switch on, and lower the magnet gradually and it will seek its own polarity. Leave it there about 5 or 10 seconds, then rock it back and forth on the charger, then turn the switch off and on two or three times, and before you turn the switch off for the last time, place a soft iron bar usually called a "keeper" across the poles of the magnet; turn the switch off, and the job is finished. There is no definite length of time to leave a magnet on the charger. However 15 or 20 seconds should be sufficient. Magnets should test anywhere from 15 to 28 pounds, depending on the size of the magnet, the quality and temper of the steel. This test can be made with a magnet meter, or with an ordinary spring scale, as previously stated under the heading of permanent magnets.

If the magnet does not test what you think it should, repeat the operation and very likely it will test 15 or 20 pounds. A magnet will only hold a certain amount of magnetism, and when it is fully charged it is said to be saturated, and will hold no more. The magnets on the later magnetos will generally test from 18 to 28 pounds. This does not include the magnets on a Ford. See figure 4.

RULE FOR MAKING A MAGNET CHARGER

This type of charger is intended to be used with a six volt storage battery, or about six dry cells. Take two soft iron cores 3 inches long by 1 inch in diameter, and drill a hole in both ends of each core; then thread the holes and fasten the two cores to a soft iron base with screws. Then take two pieces of soft iron, with a surface 1½ inches square, and fasten them to the top of each core. Make these connections perfectly tight. The core should be insulated with one or two layers of tape, or some other insulating material; also insulate so that the wire cannot come in contact with the metal at the top or bottom. A thin piece of fiber will do for his purpose. Then wind three layers of number 12 double cotton covered magnetwire (about 37 feet) on each core.

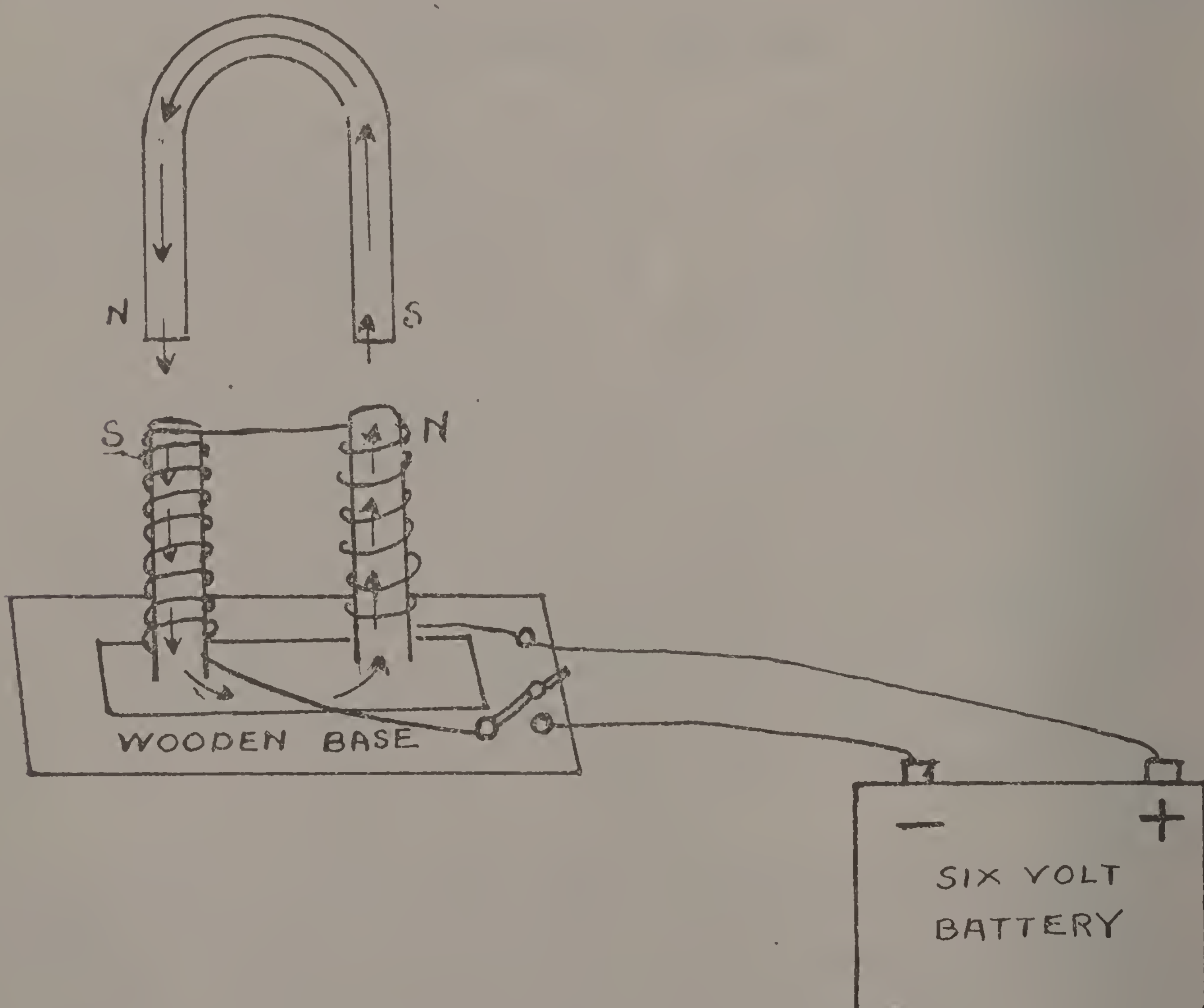


Figure 5

Wind the wire on the cores in an opposite direction to each other, thus making one a north and the other a south pole, and apply a coat of shellac on each winding to protect the insulation. You can now put on some kind of a switch. See figure 5. The arrows show the direction of the flow of the lines of force.

HIGH TENSION MAGNETO

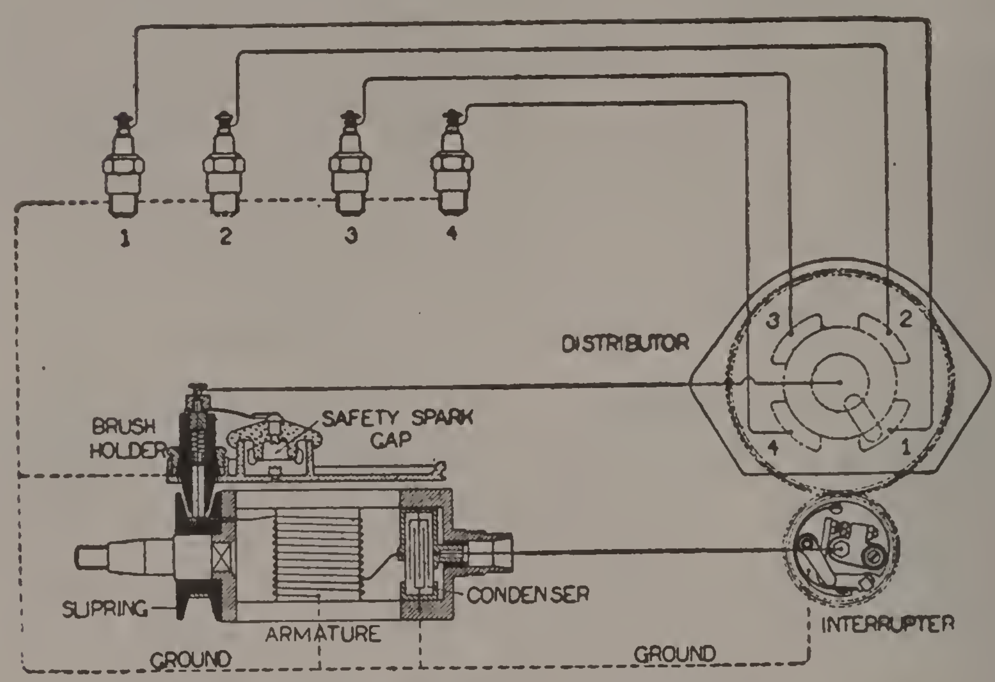
The high tension magneto is complete within itself because it has two windings on the armature, and has the condenser some place in the magneto. We will first consider a high tension magneto with a shuttle type armature (which is the standard type). On this type of armature the condenser is placed in one end of the armature, and is connected in shunt with the primary winding and the interrupter points. Shunt means the same as parallel.

We might say that the high tension magneto has the induction coil on the armature, and works on the same principle as does the low tension magneto system.

A high tension magneto of this type, consists principally of a couple of permanent magnets, two soft iron pole shoes, a bottom or base made of a non-magnetic material, an armature with two windings, and a secondary distribution.

The high tension magneto is an alternating current generator, the same as all other magnetos, and generates a current by cutting lines of force. The primary winding of this type of magneto consists of a few layers of coarse insulated wire, one end is grounded to the core of the armature, and the other is the insulated end, which is connected to the insulated interrupter point by the interrupter holding screw. The other interrupter point is grounded, which makes a connection through the ground to the ground end of the primary wire, which completes the primary circuit when the interrupter points are together.

The secondary consists of about sixty or seventy layers of very fine insulated wire, and is insulated with paraffined paper between each layer of wire, to keep the current from shorting. The secondary is grounded to the primary, not because it has to be, but it is done for convenience. The other end of the secondary is the insulated end and connects to the collector ring or slipring, which is lo-



cated on one end of the armature. The slipring is insulated on each side with hard rubber. There is a carbon collector brush which collects the current from the slipring and passes it through a conducting rod to the center of the distributor, and from there it is distributed to the different spark plugs in their order. And after the spark jumps the air gap in the spark plug it returns through the ground of the engine back to the grounded end of the secondary. It must be remembered that the armature revolves in the magnetic field, which is created by the permanent magnets, and each 180° of the armature travel, brings a different side of the armature to the side, that the north pole is on. Consequently the lines of force are reversed through the armature every 180°, which generates an alternating current. See figure 2. The shuttle type armature gives two current impulses to each revolution of the armature, which will produce a spark every 180°, or each half turn of the armature. See figure 4.

So one time the spark goes through the wire to the spark plug and returns through the ground of the engine, back to the secondary winding. And the next 180° the spark goes through the ground first, and jumps the air at the plug and returns back through the wire to the distributor and then to the secondary winding.

This is not the case with the battery system, because it sends out a direct current.

During the time the armature is passing from a horizontal to a vertical position the interrupter points are closed, which completes the primary circuit, and there is a current being generated in the primary winding, which helps the permanent field magnetize the core of the armature, and as soon as the armature reaches a vertical position the lines of force from the permanent field, go through the two heads of the armature, and at this position the interrupter points open, which causes the "neck" of the armature to die out, and the dying out of the "neck" or core induces a current in the secondary winding. So it is very important that a magneto be timed so that the interrupter points will open just as the armature is leaving the pole shoe.

The voltage of the primary winding of a high tension magneto, taking all makes into consideration, is anywhere from 30 to 60 volts. And the secondary is from 10,000 to 20,000 volts, depending on the speed of the armature. The faster it is driven the higher the voltage. A high tension magneto has a safety gap, to protect the secondary winding and keep it from burning out, in case one of the spark plug wires should become disconnected between the distributor and the spark plugs, etc. The distance of the safety gap is usually from 3/8 to 1/2 inch.

Should the hard rubber insulation on the collector ring get broken or cracked, it would be necessary to put on a new collector ring. This can be done by taking off the ball bearing and ball race. And one should have a regular ball race puller for this purpose. After the ball race has been taken off, you can take a hardwood stick and place it on the hard rubber tube, where the secondary wire enters the collector ring, and pound lightly. The secondary wire sticks in the hard rubber tube but is nt fastened in any way, so you should not experience much trouble in removing the collector ring. In replacing the new one be very careful not to crack the hard rubber insulation. Line up the projecting tube of the collector ring, with the hole in the end of the armature and push it on as far as it will go with your hands, then put on the ball race, and push it on with an arber-press, or take a piece of hollow pipe the proper size and slip over the end or the armature, and place it in a vice, and screw the vice up gradually and take great care not to push the ball race on too far, but it must be far enough to allow the ball race to be in perfect alignment with the ball ring in the end of the magneto end plate. You should also take great care in starting the end of the secondary wire into the hole of the hard rubber tube on the collection ring, so as not to allow it to bend or curl up, as it might not make a good connection.

Figure 6

To get at the condenser remove the ball race at the rear end, of the armature in this particular case, then take the screws out of the end of the armature. You can then take a soldering iron and melt the two soldered connections of the condenser, and it can then be removed. In replacing the condenser be sure that it is in good condition, and solder the connections tightly. Never attempt to repair the windings of an armature, as that is a regular factory job, and requires a special skill and machinery. It is not necessary to be an armature winder in order to be a first-class electrician, but it is necessary to be able to test armatures, etc.

An armature can be tested with a 110 volt D. C. or A. C. lighting system, by using a lamp in series with the test wires. To test the primary, hold one of the test wires on the insulated lead, and the other to any part of the armature, that is a ground, and if the lamp lights it shows that the primary winding is not broken, and is very likely all right. However, it may be short circuited. To test the secondary, place one of the test wires on the collector ring and the other on the ground, which will be most any place on the armature; the lamp will not light, but if there is no open circuit in the winding, you will note a small spark at your test wire by making and breaking the circuit. Should the lamp light it would show that there was a partial short circuit. For a final test, be sure that everything else is in first-class condition, then assemble the magneto, and if you have the equipment run the magneto at a speed of about 45 revolutions per minute and if the spark will not jump a gap one sixteenth of an inch wide, it is very likely that two or more of the layers of the secondary winding are shorted. In this case it will be necessary to replace the armature.

Another test for an armature is to use a storage battery, or six dry cells connected in series. Take two test wires leading from each side of the battery, and put one on each end of the primary winding. If you do not know where the two ends are, hold one wire on the ground, and keep trying with the other wire until you get a coil or primary flash. Of course if you get a coil flash the primary winding is all right. On the high tension magneto with the shuttle type armature, it will be found very convenient to take the interrupter off, then put the fastening screw back in the end of the armature, which makes a connection with the insulated end of the primary winding. Then take a wire and place one end on the collector ring and the other end about ⅛ of an inch from the armature. Again take the two battery wires and touch them to the two ends of the primary, and make and break the circuit which should cause a spark to jump the ⅛ inch air gap. In fact, if everything is all right it should jump about ¼ of an inch. After this test is made assemble the magneto and give the armature a quick turn by hand and if you can make the spark jump ⅛ of an inch, the magneto is all right. You should never make and break the primary circuit, without having a circuit for the secondary, as it might puncture the secondary winding.

CONDENSER TESTING

To test a condenser, take two test wires and connect to a 110 volt D. C. or A. C. lighting system, with a lamp in series, then connect the two test wires with the two condenser wires, and if the lamp lights the condenser is short circuited and is no good. See figure 7. However, if the lamp does not light, it may still be no good; it may be what is called opened circuited. To test for an open circuit, first touch your two test wires together, then make and break the circuit, and note the spark. Then connect one condenser wire to each one of the test wires, and again make and break the circuit, and if the condenser is all right you will note a snappy spark; if you note no difference in the spark, with the condenser in and out of the circuit, it is no good and should be replaced with a new one. The new one should also be tested, to make sure that it is all right before it is placed in the system.

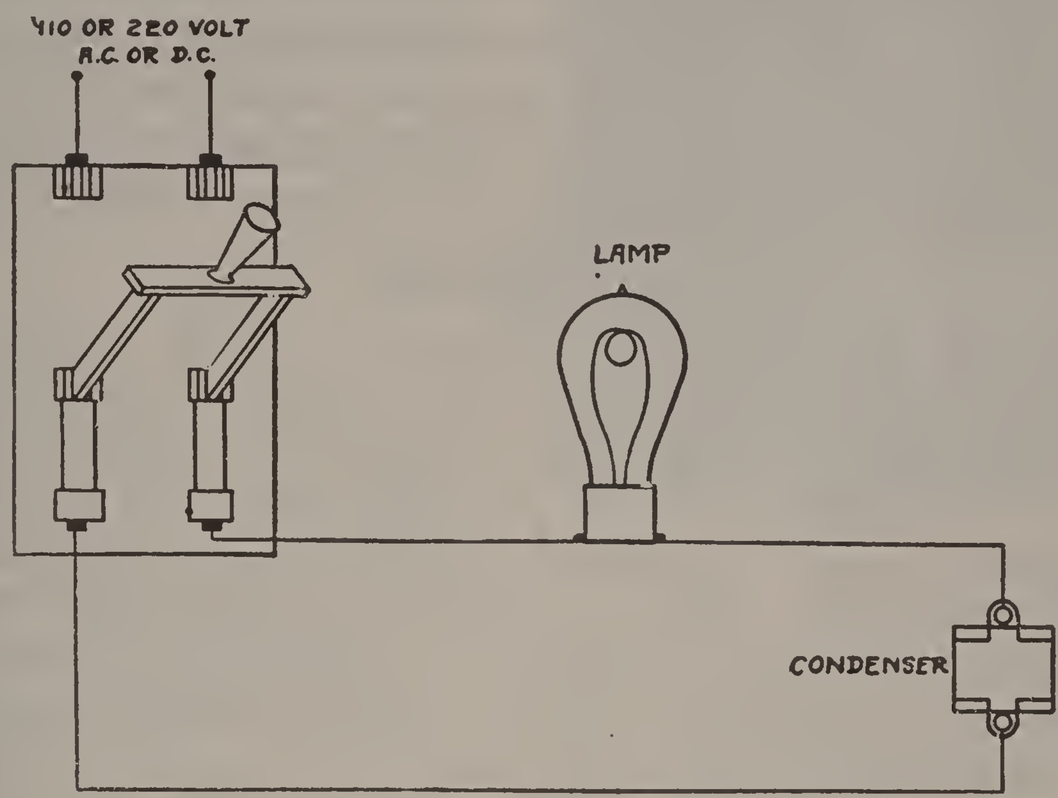


Figure 7

A simple test for a condenser is to connect it to a 110 or 220 volt circuit, direct or alternating current, with a lamp connected in the circuit in series with the condenser. When the condenser is in good condition, there should be no circuit through the condenser when the switch is closed and the lamp should not light. If the lamp lights the condenser is defective and should be replaced.

An extra good condenser will hold a charge for fifteen or twenty seconds, and sometimes longer. To make this test, take the two test wires and place on the two condenser wires, which will charge the condenser, then take the test wires off, and strike the two condenser wires together, and you should note a small spark. However, if this test fails, use the one in the preceding paragraph. On some systems one side of the condenser is grounded; in this case ground one of your test wires, and after they have been removed touch the condenser wire to the ground, and you should see a small spark.

It would be well to have a condenser on hand for testing purposes. You will find it very convenient to have wires about six inches or a foot long on each condenser terminal. Then when you see an excessive amount of sparking or flashing at the interrupter points, and a weak spark at the spark plugs, you can connect the two wires of your test condenser across the interrupter points. If this stops most of the sparking and strengthens the spark at the plugs, it will show that the condenser in the system is not working properly. Where one of the interrupter points is grounded you can ground one of the condenser wires.

COIL TESTING

To test a coil, you can use 110 volt D. C. or A. C. the same as used for condenser testing, with lamp in series. Where the switch is on the coil, it will be necessary to turn the switch on, but this will not be necessary in testing the later coils. Put the two light wires on the primary terminals; if the lamp lights the primary is very likely all right. That is, there is no open circuit. Then put one of the wires on the secondary or high tension terminal, and the other to the secondary ground, (which is either grounded to one of the primary wires, or to the core of the coil). The lamp will not light, but if secondary is all right you can see a small spark by making and breaking the circuit. If the lamp lights the winding is short circuited.

The primary winding can be tested by using two test wires connected to a six volt battery, by placing the two test wires to each one of the primary terminals, and by making and breaking the circuit it will induce a current in the secondary winding; in this case put a wire on the secondary terminal, and place the other end of the wire about 3/8 or 1/2 inch from the secondary ground; then make and break the primary circuit, and if everything is in good order the spark will jump the air gap between the secondary wire and the ground. If there is no condenser in the coil, it may be necessary to connect a condenser to the primary wires in order to make the spark jump the gap. If it will jump a 1/2 inch in the open, it will insure a good spark under compression, as it takes about 15,000 volts to jump a 1/2 inch air gap. In making this test be sure and have a circuit for the secondary, otherwise it might damage the winding.

INSTRUCTIONS FOR BOSCH HIGH TENSION MAGNETOS D U TYPES

The Bosch Magnetos, Types DU1, DU2, DU4-2, DU3, DU4 and DU6, are of the high tension series, and are used respectively on one, two, three, four, and six-cylinder engines of the automobile type, in motor car, marine, tractor, and stationary service.

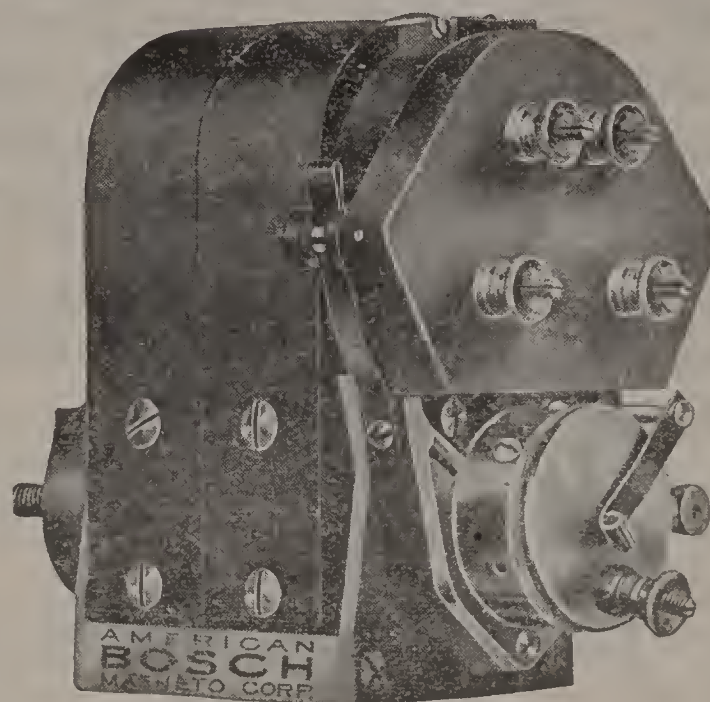


Figure 8.

The type DU magnetos are usually employed as sole ignition on an engine, or, in some cases, in connection with a battery system operating on a separate set of spark plugs. The DU magnetos, without alteration, are also employed to provide battery and magneto ignition on one set of spark plugs, this being accomplished by means of the Bosch Vibrating Duplex Ignition System, a separate booklet describing which may be had on request. The Bosch Independent Magnetos, DU Types, are those described in this booklet.

GENERATION OF CURRENT

Like other Bosch High Tension Magnetos, the types DU generate their own high tension current directly in the magneto armature (the rotating member of the magneto), without the aid of a separate step-up coil, and have their timer and distributor integral.

The armature winding is composed of two sizes of wire, one size comparatively heavy and the other very fine. The heavy wire constitutes the primary or low tension circuit, and the very fine wire the secondary or high tension circuit.

The rotation of the armature between the poles of strong permanent magnets sets up or induces a current in the armature primary circuit, and this is further augmented at regular intervals in the rotation of the armature shaft by the abrupt interruption of the primary circuit by means of the magneto interrupter. At the opening of the primary circuit, the resulting discharge of current from that circuit induces a current of high voltage in the armature secondary circuit. The high tension current thus created is collected by the slipring on the armature and passed through the slipring brush, then to the various magneto distributor terminals, each of which is connected by cable to the spark plug in its respective cylinder. The operation of the instrument will be more clearly understood from a study of the complete circuits, primary and secondary, which follow.

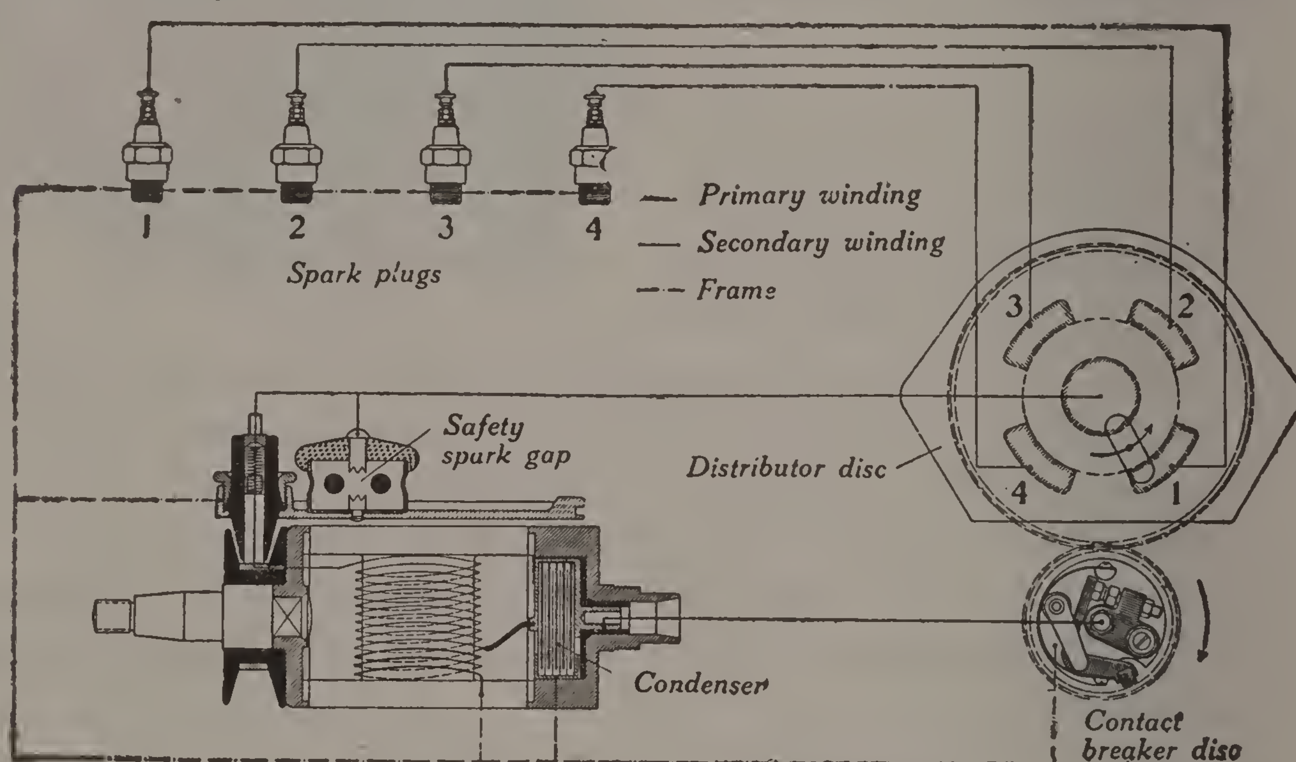


Figure 9.

PRIMARY OR LOW TENSION CIRCUIT

The beginning of the armature primary circuit is in metallic contact with the armature core, and the end of the armature primary circuit is connected, by means of the interrupter fastening screw, to the insulated contact block supporting the long platinum contact on the magneto interrupter. The interrupter lever, carrying a short platinum contact, is mounted on the interrupter disc which, in turn, is electrically connected to the armature core. The primary circuit is completed whenever the two platinum interrupter contacts are brought together, and interrupted whenever these contacts are separated. The separation of the platinum contacts is controlled by the action of the interrupter lever as it bears against the steel segments secured to the inner surface of the interrupter housing; the types DU1 and DU4-2, 360°, are each provided with but one interrupter segment, while all other DU types have two such segments.

The high tension current is generated in the secondary circuit only when there is an interruption of the primary circuit, the spark being produced at the instant the platinum interrupter contacts separate.

SECONDARY OR HIGH TENSION CIRCUIT

The armature secondary circuit is a continuation of the armature primary circuit, the beginning of the secondary being connected to the primary, while the end of the secondary is connected to the insulated current collector ring, or slipring, mounted on the armature just inside the driving shaft end plate of the magneto. This form applies in all DU types except the DU1 two-spark magneto.

In Types DU4-2, DU3, DU4 and DU6, the slipring brush, which is held in contact with the slipring by the brush holder at the shaft end of the magneto, receives the high tension current collected by the slipring and, by means of the connecting bar under the arch of the magnets, passes the current to the metal contact in the center of the distributor plate. From the latter point the high tension current passes to the distributor brush, which is held in a brush holder mounted on the distributor gear and, consequently, rotates with the gear.

Metal segments are imbedded in the distributor plate, and as the distributor brush rotates, it makes contact successively with the segments in the distributor plate.

The segments in turn are connected with the terminal studs on the face of the distributor plate, and the latter are connected by cables to the spark plugs in the various cylinders. In the cylinders, the high tension current produces a spark which causes ignition and then returns through the engine to the magneto armature, thus completing the circuit.

In Type DU2, the slipring groove is provided with a sectional metal segment, and the end of the armature secondary circuit is connected to this segment. The metal segment acts not only as a current collector, but also as a high tension distributor, for, at every 180° revolution of the armature, the segment alternately comes into contact with, and delivers high tension current to, one of the two slipring brushes which are horizontally mounted in the brush holders on opposite sides of the shaft end plate. High tension cables from the brush holder terminals connect the slipring brushes with the spark plugs in the cylinders.

In Type DU1, Single-Spark, for one-cylinder engines, no distributor is required, and the high tension current from the armature secondary circuit is passed by the slipring to a single brush, which is supported by a brush holder at the shaft end of the magneto. A high tension cable between the brush holder terminal and the spark plug in the cylinder completes the secondary circuit.

In Type DU1, Two-Spark, the armature secondary circuit is insulated from the armature primary circuit, and the two ends of the secondary are connected to two sectional metal segments, diametrically opposite on a single slipring. Two slipring brushes are provided which, as in the type DU2, are horizontally mounted in brush holders on opposite sides of the shaft end plate; during that portion of the armature rotation when high tension current is being delivered, each of the two slipring segments will be in contact with one of the brushes. The secondary circuit is completed by a high tension cable from each brush holder terminal to a spark plug, and a spark will pass at both plugs simultaneously.

SAFETY SPARK GAP

In order to protect the armature and other current carrying parts, a safety spark gap is provided.

Under ordinary conditions, the current will follow its normal path to the spark plug, but if for any reason the electrical resistance in the secondary circuit is increased to a high point, as when a cable becomes disconnected or a spark plug gap too wide, the high tension current will discharge across the safety gap.

The current should never be allowed to pass across the safety spark gap for any length of time, and if the engine is operated on a second or auxiliary ignition system, the magneto must be grounded in order to prevent the production of high tension current. The snapping sound by which the passage of the current across the safety gap may be noted should always lead to an immediate search for the cause of the difficulty.

In Types DU4-2, DU3, DU4 and DU6, the safety spark gap is arranged on the dust cover over the armature, and consists of two short pointed electrodes supported a short distance from each other; one electrode is set on the dust cover itself and inclosed by a metal and wire gauze housing, while the other, or insulated electrode, is set in the center of the steatite cover of the safety spark gap housing and connected into the secondary circuit of the magneto.

In Types DU1 and DU2, the safety spark gap consists of a short pointed wire projecting from the armature insulating material, the end of this wire extending to within a short distance of the armature cover at the driving shaft end.

TIMING RANGE

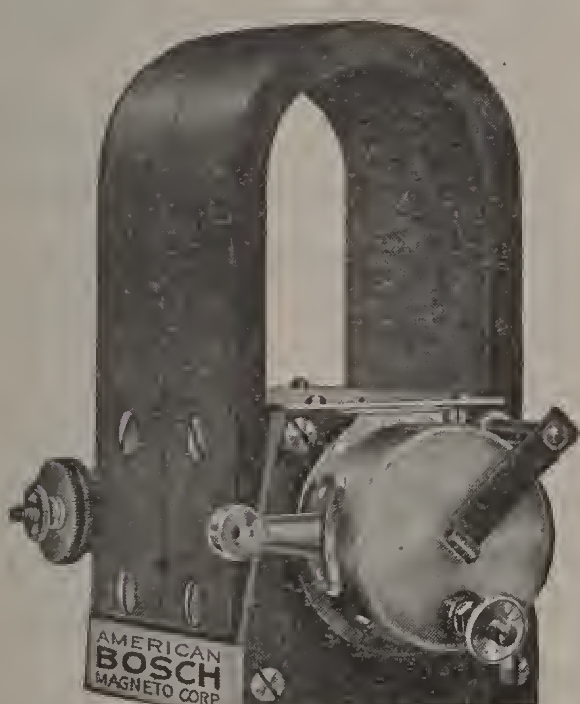


Figure 10.
Bosch Magneto Type DU2

The magneto interrupter housing is arranged so that it may be rotated through an angle of 35° with respect to the armature shaft. The movement of this housing in one direction or the other causes the interrupter lever to strike the steel segments earlier or later in the revolution of the armature, the spark occurring correspondingly earlier or later in the stroke of the piston.

The spark can be advanced by moving the interrupter housing, by means of the timing control arm, in the direction opposite the rotation of the armature, and can be retarded by moving the interrupter housing in the same direction as the rotation of the armature. The armature rotation is indicated by the arrow on the oil well cover at the driving shaft end of the magneto.

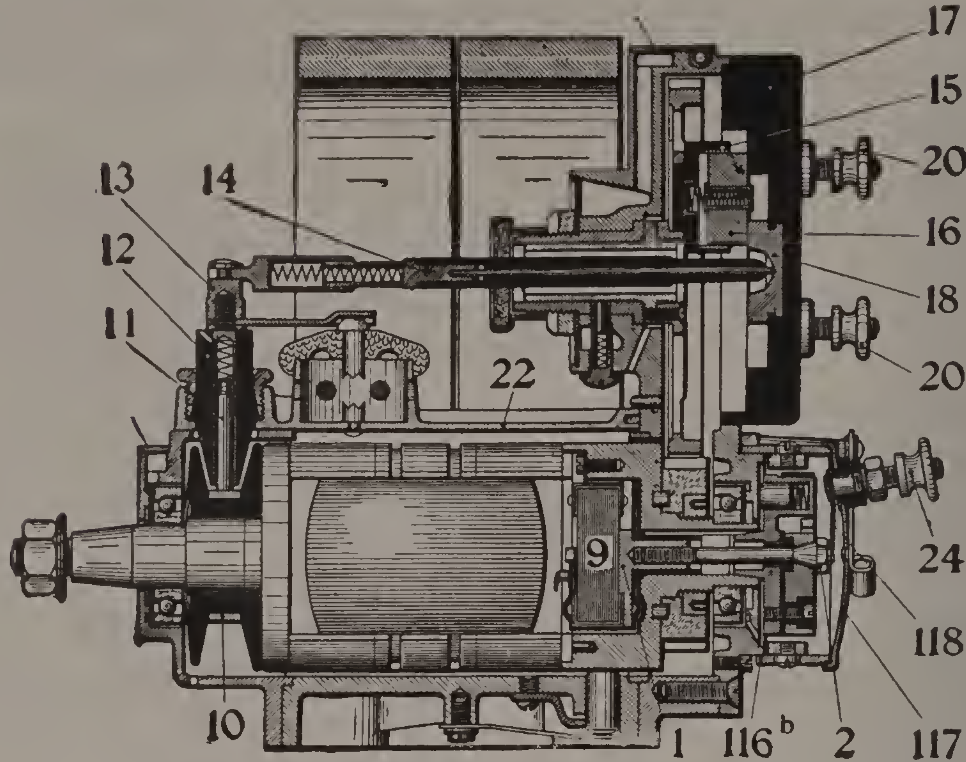


Figure 11.

1. Brass plate for connecting the end of armature primary circuit.
2. Fastening screw for magneto interrupter.
9. Condenser.
10. Slipring.
11. Slipring brush.
12. Slipring brush holder.
13. Slipring brush holder.
14. Connecting bar.
15. Distributor brush holder.
16. Distributor brush.
17. Distributor plate.
18. Central distributor contact.
20. Terminal nut for distributor plate.
22. Dust cover over armature.
24. Terminal nut for grounding terminal.
116b. Interrupter housing and timing arm.
117. Cover for interrupter housing.
118. Contact Spring for grounding terminal.

CUTTING OUT THE IGNITION

Since high tension current is generated only on the interruption of the primary circuit, it is evident that in order to cut out the ignition it is necessary merely to divert the primary current to a path which is not affected by the action of the magneto interrupter. This is accomplished as follows:

An insulated grounding terminal is provided on the cover of the magneto interrupter housing with its inner end, consisting of a spring with carbon contact, pressing against the head of the interrupter fastening screw. The outer end of the grounding terminal is connected by low tension cable to one side of a switch, and the other side of the switch is grounded by connecting another cable between it and the engine or chassis.

When the switch is open, the primary current follows its normal path across the platinum interrupter contacts and is interrupted at each separation of these contacts; however, when the switch is closed, the primary current passes from the head of the interrupter fastening screw to the carbon contact of the grounding terminal, thence through the switch to the engine and back to the magneto, and as the primary current remains uninterrupted when following this path, no ignition current is produced.

CARE AND MAINTENANCE

Aside from keeping the magneto clean externally, practically the only care required is the oiling of the bearings; of these, there are two ball bearings supporting the armature, and in the types with gear driven distributor,, a single plain bearing supporting the shaft of the distributor gear.

Any good, light machine oil may be used for this purpose (never cylinder oil), and each of the bearings should receive not more than two or three drops about every 500 miles, applied through the oil ducts under the covers marked "Oil" located at both ends of the magneto.

The interrupter is intended to operate without lubrication, and as oil on the platinum interrupter contacts will prevent good contact, cause sparking and burning, as well as misfiring, care should be exercised to prevent the entrance of oil to these parts.

Starting the Engine: When cranking an engine equipped with a DU magnet as sole ignition, the spark lever should be fully retarded if the magneto is of the Model 5 or Model 6 construction (most of the DU1 and DU2 magnetos are of these models), but should be slightly advanced with all other models. In the latter case, if the magneto has been timed according to instructions, the spark lever may be safely advanced about one third, or even one half on starter equipped engines, and in this position will permit easier starting (see also "Plug Gap Too Wide," on page 38).

TROUBLE—CAUSE AND REMEDY

Ignition difficulties may be divided into two main classes, one. the most common, due to spark plugs and cables, and the other, comparatively infrequent, due to the magneto. In case of defective ignition, therefore, it must first be determined whether the fault is in the magneto or, as is more probable, elsewhere.

In general, when only one cylinder misfires the fault is in the spark plug, the most common plug difficulties being as follows:

Plug Gap Too Wide: The distance between the electrodes of the spark plugs varies according to the individuality of the engine, but normally this distance should not be less than 1-50th inch. On the other hand, however, too wide a gap increases the electrical resistance, and interferes with the proper generation of current at low sped. Difficulty in starting an engine and missing at low speeds are very often due to the spark plug gaps being too wide and, as the spark will have a tendency to burn the electrodes and thereby gradually increase the gap, it is especially important that the plugs be examined occasionally for assurance that the gap is not too great; any difficulty due to this cause may be readily overcome by readjusting the electrodes.

Plug Short-Circuited: This is usually caused by a cracked or porous insulator, or by fouling of the electrodes or insulator. Any of these conditions will cause misfiring by permitting the current to stray from its intended path. In Bosch Spark Plugs the possibility of trouble from such causes is reduced to a minimum.

Longitudinal Section of DU1 Magneto

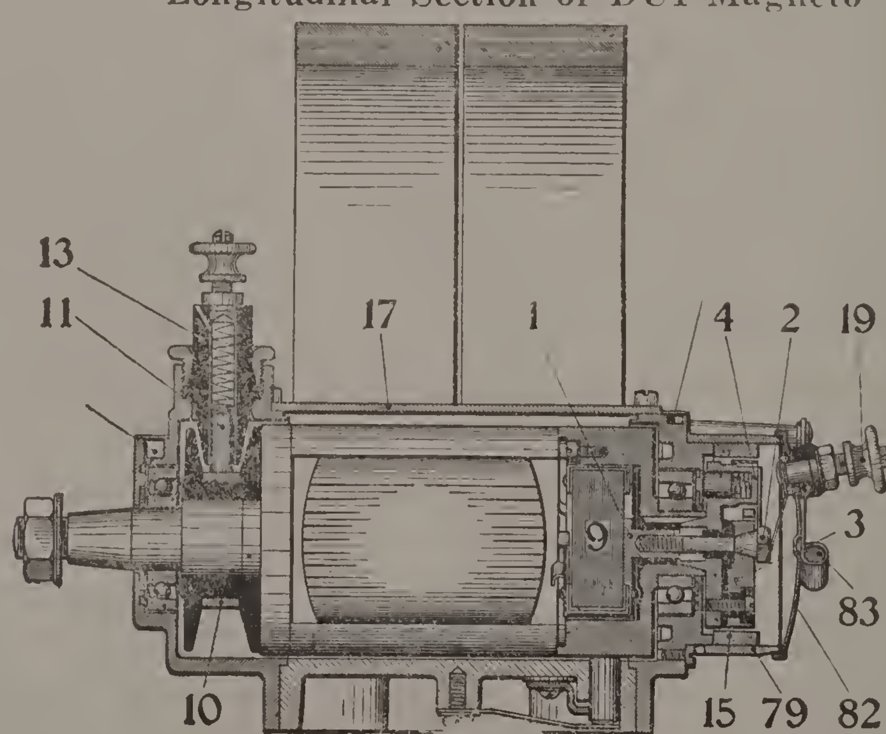


Figure 12

Rear View of DU1 Magneto
(Interrupter Housing Cover Removed)

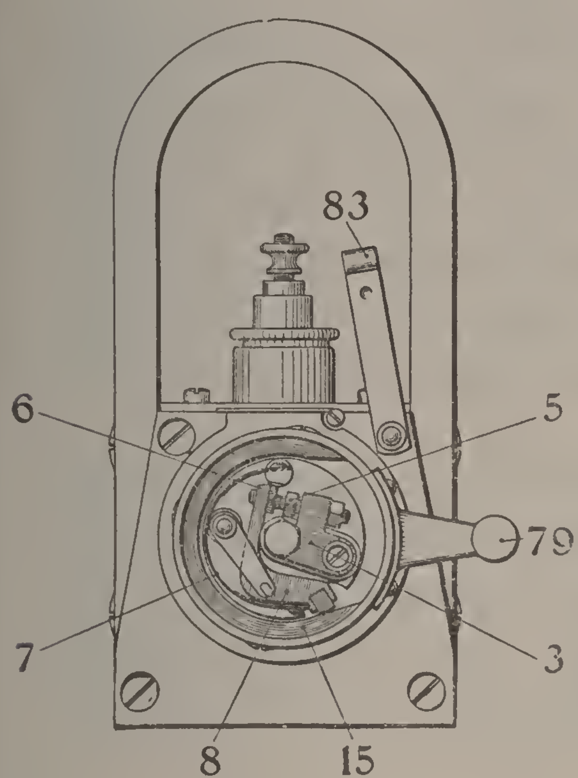


Figure 13

1. Brass plate for connecting the end of armature primary circuit.
2. Fastening screw for magneto interrupter.
3. Contact block for magneto interrupter.
4. Magneto interrupter disc.
5. Long platinum screw.
6. Short platinum screw.
7. Long flat spring for magneto interrupter lever.
8. Magneto interrupter lever.
9. Condenser.
10. Slipring.
11. Slipring brush.
13. Slipring brush holder.
15. Steel segment for interrupter housing.
17. Dust cover over armature.
19. Terminal nut for grounding terminal.
79. Interrupter housing and timing control arm.
82. Cover for interrupter housing.
83. Spring for holding interrupter housing cover.

OTHER FAULTS

Cables: Misfiring of one cylinder, either continuous or intermittent, may be due also to a chafed or broken cable or to a loose connection. The cables should be carefully examined, special attention being paid to the insulation. The metal terminals of the cables must not come into contact with any metal parts of the engine or of the magneto, except those designated as being correct according to the instructions given.

Ignition Fails Suddenly: A sudden failure of ignition may indicate a short circuit in the low tension cable, due either to a defect in the cable, to a faulty connection at the switch, or to the presence of dirt or moisture. A test for trouble in the switch or low tension cable can be made by removing the cable from the grounding terminal on the cover of the magneto interrupter housing and endeavoring to start the engine on the magneto. If the engine runs with this wire disconnected but stops when the wire is connected, it is evident the magneto is in good order and that the trouble is due to some fault in the switch or grounding wire permitting the low tension current to escape to ground.

Irregular Firing: If the cables and plugs are in good condition, and yet the ignition is irregular, the trouble is probably with the magneto, and the interrupter should be carefully examined. It should be seen that the interrupter lever moves freely on its pivot, that the hexagon headed fastening screw in the center of the interrupter is properly tightened, and also that the two platinum interrupter contacts are properly secured in position.

If the interrupter lever does notmove freely on its pivot, which is sometimes possible, particularly with new magnetos, the hole in the fibre bushing in which the lever pivots may be slightly enlarged by means of a reamer or small round file; this work, however, should be carefully done as very little reaming accomplishes the desired result.

Platinum Interrupter Contacts: The platinum interrupter contacts should be examined for the correctness of their adjustment, and they should be so set that they are separated by a distance of 0.4 of a millimeter (about 1-64th inch) when the interrupter lever is resting on either of the segments in the interrupter housing. The strip of steel attached to the Bosch magneto adjusting wrench, which is furnished with each magneto, is to be used as a gauge for this distance. The adjustment of the platinum interrupter contacts may be made by loosening the lock nut of the long contact screw, which passes through the interrupter contact block, and turning the hexagon head of the screw itself by means of the before mentioned Bosch adjusting wrench. When the adjustment is made, care should be taken to tighten the lock nut firmly.

The platinum contacts of the interrupter should be clean and in proper alignment with each other, and any oil, grease or dirt that is deposited on them should be removed. If they are uneven or in bad condition (but only then) they may be smoothed by means of a fine, flat, jeweler's file. The platinum contacts should be kept clean, and in that condition and with proper attention they will last a considerable length of time.

The interrupter itself may be taken out as a unit by removing the interrupter housing and withdrawing the hexagon headed fastening screw in the center of the interrupter by means of the Bosch adjusting wrench. Should the interrupter stick on its seat after the fastening screw is withdrawn, it may be pried loose by means of two small screw drivers inserted back of the interrupter disc, one on each side. When replacing the interrupter, care must be taken that the key on the interrupter disc fits exactly into the keyway on the armature shaft.

Damaged Insulating Parts: As it sometimes happens that brush holders and other insulating parts of the magneto are damaged through accident or carelessness, these parts should also be carefully examined for possible disarrangement or damage of the insulation which might permit leakage of current.

SUMMARY OF TROUBLES

In brief, providing the magneto is properly timed to the engine, trouble due to ignition may be as follows:

Engine Will Not Start: Switch closed, switch or switch wire short-circuited, interrupter lever sticks; also, with single and two-cylinder types, defective or dirty spark plug, broken or disconnected high tension cable, defective cable insulation, damaged brush holder.

Engine Stops Abruptly: Switch closed, switch or switch wire short-circuited; also, with single and two-cylinder types, spark plug cable disconnected.

Misfiring at Low Speed: Spark plug gap too wide.

Misfiring at All Speeds: Defective or dirty spark plug, improper spark plug gap, cable insulation chafed, cable connections loose, brush holder cracked, platinum interrupter contacts dirty or oily, interrupter lever sticks.

SPARK PLUGS

It may be pointed out that inasmuch as ignition defects are due largely to dirty or defective spark plugs, most such trouble can be avoided by using plugs which are properly designed and constructed.

The characteristics of a suitable plug are: An unbreakable and positive insulator, solid construction, which absolutely prevents leakage, multipoint electrodes of such metal as will resist burning and a design which will tend to operate irrespective of the effects of excessive oiling and sooting. The Bosch Plug meets all these requirements.

INSTALLATION OF MAGNETO

Driving Method—Driving Speed.

Since the magneto produces an ignition spark only at certain definite points in the rotation of its armature, it must be connected to the engine in such a manner that the spark is available always at the instant when required in the cylinder, i. e., about top dead center of the compression stroke. The magneto, therefore, must be positively driven from the engine by a method of drive that will eliminate slippage; belt or friction drive cannot be used.

The Type DU6 magneto, producing two sparks per revolution of its armature shaft, must be driven at one and one half times engine speed for six-cylinder, four-cycle engines, and at three times engine speed for six-cylinder, two-cycle engines. The type DU4 must be driven at engine speed (crank shaft speed) for four-cylinder, four-cycle engines, and at twice engine speed for four-cylinder, two-cycle engines. The type DU3 must be operated at three-quarter engine speed for three-cylinder, four-cycle engines, and at one and one half times engine speed for three-cylinder, two-cycle engines.

The type DU4-2, 360° is intended to be operated at engine speed on two-cylinder, four-cycle engines, the cylinders of which fire alternately every 360° revolution of the crank shaft; for two-cylinder, two-cycle engines, this type must be driven at twice engine speed. The type DU4-2, 180°, for two-cylinder, four-cycle engines, the cylinders of which fire at intervals of 180° and 540°, must be operated at engine speed.

The type DU2 must be driven at half engine speed (camshaft speed) for two-cylinder, four-cycle engines where the cylinders fire alternately every 360° revolution of the crank shaft; for two-cylinder, two-cycle engines, this type must be driven at engine speed.

The type DU1 must be driven at camshaft sped for single-cylinder, four-cycle engines, and at engine speed for single-cylinder, two-cycle engines. Where the type DU1, two-spark, is used on two-cylinder, four-cycle engines, the Bosch Magneto Company, New York, or any of its branches, should be consulted as to proper driving speed.

Direction of Rotation: The type DU magnetos are designed to run in one direction only, that is, clockwise or anticlockwise, as viewed from the shaft end of the magneto. The direction in which each magneto is designed to run is indicated by an arrow on the cil well cover at the shaft end of the magneto.

TIMING THE MAGNETO

With the average four or two-cylinder engine, the proper operating results are obtained by timing the magneto as follows:

For types DU4-2, DU3, DU4, and DU6: The crank shaft is rotated to bring the piston of Number 1 cylinder (in automobile practice this is the cylinder nearest the radiator exactly on top dead center of the compression stroke, and the piston is to be maintained in that position. The magneto is then to be secured to its bracket or bed on the engine, and the timing control arm on the interrupter housing placed in the fully retarded position.

With that done, the magneto distributor plate should be removed by withdrawing the two holding screws, or depressing the two catch springs, as the case may be, thus exposing the distributor gear and brush. The cover of the magneto interrupter housing is also to be removed to permit observation of the interrupter.

The armature should then be rotated by means of the exposed distributor gear in the direction in which it is to be driven until the platinum interrupter contacts are just about to separate, which occurs when the interrupter lever begins to bear against one of the steel segments of the interrupter housing.

The armature should be held in that position while the magneto drive is connected to the engine, due care being taken that the piston of Number 1 cylinder is still exactly on top dead center of the compresison stroke. The installation is completed by replacing the interrupter housing cover and distributor plate, and connecting the cables between the magneto and spark plugs

For Types DU2 and DU1: These types should be timed to the engine in the same manner as described above for the types with gear driven distributor, except that with the DU2 and DU1, the dust cover over the armature should be removed to facilitate rotation of the armature by hand during the timing; the dust cover should be replaced as soon as the magneto has been connected to the engine.

Exact Magneto Timing. The foregoing will establish the desired relationship between the magneto armature and the engine crank shaft. It should be noted, however, that while these instructions cover the average engine, the exact magneto timing for individual engines is best determined by trial. Where specific instructions for magneto timing are given by the engine manufacturers, it is recommended that such instructions be followed in preference to those herein given.

HIGH TENSION CABLE CONNECTIONS

For Types DU4-2, DU3, DU4, and DU6: After timing and connecting the magneto to the engine in accordance with the foregoing instructions, and while the piston of Number 1 cylinder is still on top dead center of the compression stroke, it should be observed with which one of the metal distributor segments the distributor brush will be in contact when the distributor plate is returned to position, and the terminal stud attached to that distributor segment is to be connected by a high tension cable to the spark plug of Number 1 Cylinder.

The remaining distributor terminals should be connected to the spark plugs in the other cylinders according to the firing order of the engine and the order in which the rotating distributor brush makes contact with the metal segments in the distributor plate. Thus the second distributor segment to receive contact is to be connected to the second firing cylinder, the third distributor segment to receive contact is to be connected to the third firing cylinder, etc. In making these connections it should be borne in mind that the distributor brush rotates in the direction opposite to the rotation of the armature.

For Type DU2: With the magneto interrupter and piston of the first firing cylinder in the position above described, the spark plug of that cylinder should be connected with the brush holder. the brush of which is in contact with the metal segment of the slipring, and this can be seen by removing one of the brush holders. If the metal segment of the slipring is not visible through the opening of the brush holder thus removed it is evidently in contact with the brush in the opposite holder, and the latter must in such case be connected to the spark plug of the first firing cylinder. The spark plug of cylinder Number 2 is then to be connected to the remaining brush holder.

For Type DU1: With the type DU1, the installation is completed by connecting a high tension cable from the brush holder terminal to the spark plug (or from both brush holder terminals to both spark plugs, in the two-spark type).

BOSCH DUPLEX IGNITION SYSTEM

The Bosch Duplex Ignition System offers a simple method for starting the engine at the slowest cranking speeds, by combining a battery circuit with any of the Bosch High Tension Magnetos arranged for Duplex Ignition. While this book deals only with "DU" types of Bosch Magneto, the same system has been applied to the "NU"; "ZU" and "ZR" types.

Aside from the battery, the Bosch Duplex Ignition System consists of a duplex magneto and low tension duplex coil, the arrangement being such that, while the magneto circuit is complete in itself, as in Bosch independent magneto types, the battery circuit includes the battery and coil which act in conjunction with the magneto. The same set of spark plugs is employed for the magneto and battery both.

The battery side of the outfit is not intended to be used as a separate ignition system but merely as an auxiliary to the magneto to insure easy starting by cranking.

OPERATION ON THE BATTERY SIDE

Under this condition the primary winding of the magneto armature is included in the battery circuit, together with the duplex coil, and the action of the battery is to supplement the normal action of the magneto which, at extremely low speed, is not sufficient of itself to produce a high tension spark.

As the magneto generates an alternating current which changes its direction of flow every 180° revolution of the armature, it is necessary, in order that the battery may assist the magneto, that the battery current be held in phase with the magneto current, and for this purpose a commutator in simple form is provided on the inner surface of the interrupter housing cover. By means of the commutator the battery current is caused to flow in the same direction as the magneto current, and a change in the direction of the latter is accompanied by a corresponding change in the direction of flow of the battery current through the primary winding of the magneto armature.

With the starting of the engine, and at the slowest speed at which the engine will run, the necessity for the battery ceases, for at such a speed the magneto is capable of producing a satisfactory ignition spark. At this point there will be no difference in the operation of the engine whether the switch is left in the battery position or is thrown to the magneto position.

However, in order to reduce the battery consumption, it is advisable to throw the switch to the magneto position as soon as the engine has started.

OPERATION ON THE MAGNETO SIDE

When the switch is thrown to the magneto position, the battery connection is interrupted and the operation of the magneto is identical in every way with the operation of an independent magneto.

It should be noted particularly that the battery and duplex coil are employed in the battery circuit only, and not in the magneto circuit, so that the removal of either, or both, would in no way affect operation of the magneto.

BOSCH DUPLEX MAGNETO

Aside from the interrupter and interrupter housing, which are described below, the construction of the duplex magneto is the same as that of the corresponding independent type, and complete information regarding the former may be obtained from the instruction book for the latter.

The interrupter housing cover consists of a fibre disc, which is maintained in a fixed relation to the housing by a key and keyway. The inner surface of the disc is provided with two metal segments, each connected to a terminal on the outer surface of the cover, as shown in the accompanying diagram.

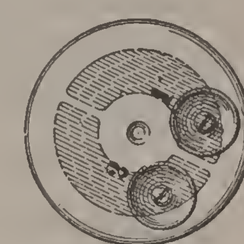


Figure 14

The interrupter is provided with two brushes which, upon rotation of the magneto armature, sweep the two metal segments; the two segments constitute the commutator. This construction

DU4 Duplex Magneto partly disassembled

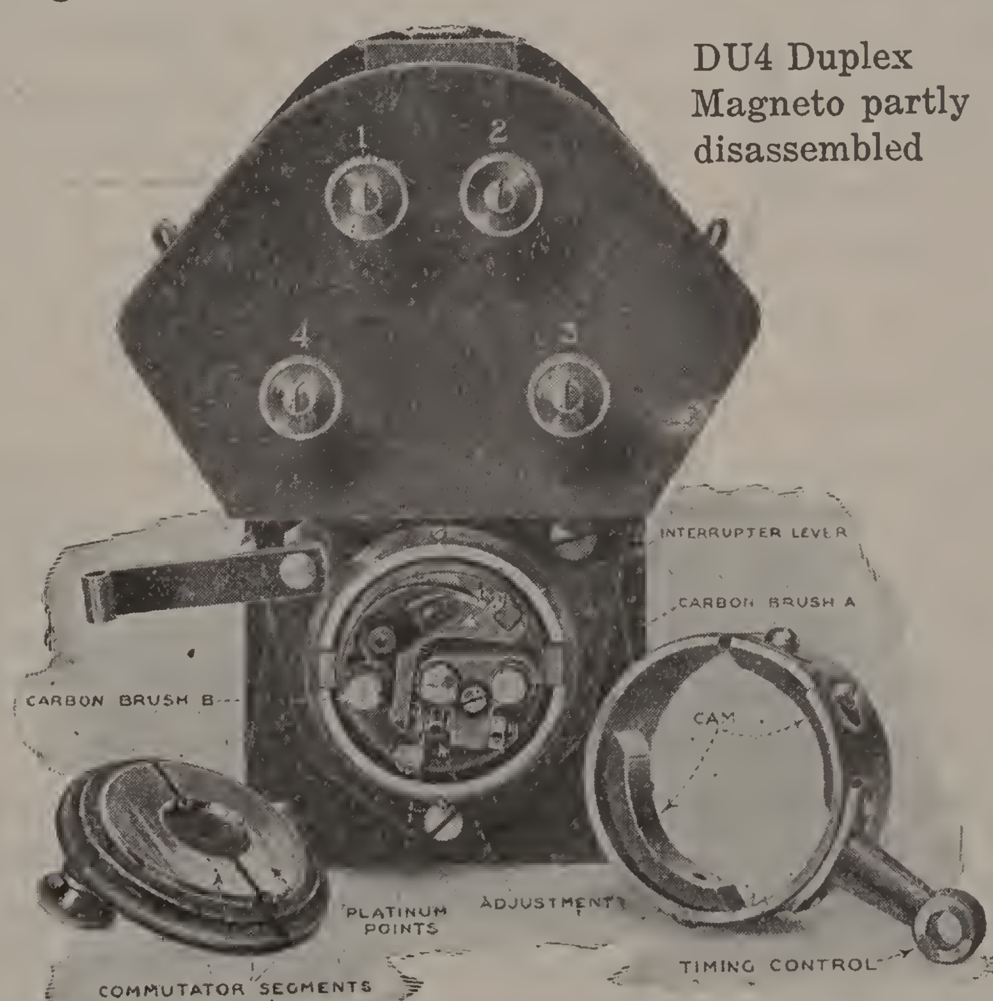


Figure 15

provides for the reversal of current necessary to hold the battery current in phase with that of the magneto.

BOSCH DUPLEX COIL

The duplex coil consists of a stationary cylindrical housing containing a simple primary coil, and the parts that form the switch. The housing is fitted with a flange by which it may be attached to the dashboard, bulkhead, or other support.

The iron core of the coil carries a switch plate, embedded in which are metal segments to which both ends of the coil winding are connected; by moving the switch handle, the segments in the switch plate may be brought into contact with contact springs on the stationary switch plate 9110, 9197 or 9501. The iron core also supports the coil cover 9186, which is provided with a switch handle by which the cover 9186, together with the coil winding and switch plate, may be moved as a unit from one switch position to another.

The four coil terminals are connected electrically with the contact springs on the stationary switch plate, and are to be connected with the magneto and battery in accordance with the numbers and figures marked on the magneto and coil, and shown in the wiring diagrams on page 56.

Press Button Style of Coil: The types "M" and "Ma" duplex coils, used in connection with several models of duplex magnetos, are provided with a press button which, under certain conditions, will permit starting on the spark.

Where the press button is provided, it passes through an opening in the center of the core of the coil, and a spring causes it normally to project from the face of the coil. When the press button is depressed, its lower end comes into contact with an arm which, in turn, operates a make-and-break device carried on the inner side of the stationary switch plate 9110.

The make-and-break device consists of a steel blade secured at one end to the stationary switch plate contact connected to coil terminal "Magneto 1"; the other end of the blade carries a supplementary blade with a platinum point. The movement of the make-and-break arm by the press button causes the platinum point on the blade to come into contact with, and then to separate from, a second platinum point carried on the stationary switch plate contact connected to the terminal marked "Magneto 2."

SWITCH

The switch is in the "Off" position when the cover is rotated in the left-hand direction to the limit of motion.

The first position from that point is marked "Battery" and, with the connections then made, the system will operate on battery and on magneto. The ignition spark will then be produced by the action of the magneto current supplemented by that of the battery and coil.

The second movement of the switch throws it to the "Magneto" position, and cuts out the battery.

The stop screw 9076 limits in both directions, the movement of the switch.

The switch is provided with a key lock, and this is so arranged that it may be locked and the key removed only in the "Off" position. This serves to protect the battery from being run down through the switch being left in the battery position with the engine at rest, and also prevents unauthorized operation of the engine.

BATTERY

The coil is wound for six volts, and a six-volt, sixty ampere hour storage battery is recommended.

Dry cells may be used, however, in which case it is advisable to install ten, connected in multiple series. The cells should be divided into two groups of five, the cells of each group being connected in series, or, in other words, the carbon of one cell being connected to the zinc of the next. This will leave one carbon terminal and one zinc terminal of each group free, and the two groups should be connected by leading a wire from the carbon of one group to the carbon of the other, and a second wire from the zinc of one group to the zinc of the other. The arrangement described is shown on next page.

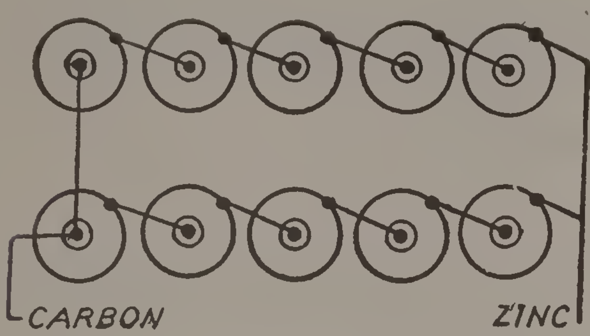


Figure 16

The wire from the carbon terminal of the battery should then be led to the "Battery +" terminal on the coil, while the wire from the zinc terminal of the battery should be led to the "Battery—" terminal on the coil.

STARTING THE ENGINE

By means of the Bosch Duplex System a spark sufficient for ignition purposes is produced at the lowest cranking speed, rendering the cranking of any engine so equipped a comparatively easy matter.

To start the engine, the spark lever should be fully retarded and the switch thrown to the battery position, the latter action placing the duplex coil, together with the battery, in series with the primary winding of the magneto. Under such a condition, at each separation of the magneto interrupter screws, the current from the battery passes through the primary winding of the magneto armature and induces in the secondary winding a current of very high voltage, which is more than sufficient for ignition purposes even at the lowest engine cranking speeds.

When starting an engine equipped with the type "M" or "Ma" duplex coil, the spark lever should be fully retarded, the switch thrown to the battery position, and the push button on the coil depressed and released. The arrangement is such that the battery circuit is made and broken twice during the depression and twice during the release of the press button. It should be remembered, however, that as the magneto interrupter screws and the press button contacts are in parallel, starting on the push button can be accomplished only when the magneto interrupter is open; pressing the button when the interrupter is closed will not break the primary circuit and under such conditions there will be no induction of high voltage current in the secondary winding of the magneto armature.

If the engine does not start on the press button, it may be taken for granted that the cylinders do not contain gas, or that the engine has stopped in such a position that the magneto interrupter screws are closed. It will then be necessary to crank the engine, in which case the action is exactly the same as with duplex coils having no press button.

CURRENT CONSUMPTION

As in the case with all battery systems, the current consumption will be highest if the switch is thrown to the battery position with the engine at rest. When the engine is started the current consumption drops immediately, but to preserve the battery the switch should be thrown to the magneto position as soon as the engine starts. It will be noted that operation is positive with the switch either in the battery or in the magneto position. The necessity for the battery current to supplement the magneto current exists only at very low cranking speeds, and the assistance of the battery is unnecessary as soon as the engine starts. Inasmuch as the battery and the magneto are connected in parallel, there will be no interference with the operation of the engine if the battery is disconnected, even with the switch in the battery position, as, under such conditions, the duplex magneto operates exactly the same as an independent instrument.

CONNECTIONS

The action of the system holds the battery current in phase with the magneto current, and it is therefore essential that the battery be correctly connected. If the connections are incorrectly made, so that the flow of magneto and battery currents are opposite in direction, no sparks will be produced. If the engine starts on pressing the button, or by cranking, but stops after it has made a few revolutions, it is safe to assume that the battery is wrongly connected.

This fault may be corrected by reversing the battery connections either at the battery or at the coil.

The reason for this action of the engine is that with the magneto at rest, there is no opposition to the flow of battery current, and it acts on the armature winding in a normal manner. With the starting of the engine and the rotation of the armature, however, the flow of magneto current is opposite in direction to the flow of battery current, and the inducing of high voltage in the secondary winding of the magneto armature is prevented.

BATTERY SYSTEM MUST NOT BE GROUNDED

The arrangement of the duplex system makes it imperative to prevent the battery current from becoming grounded, and ignition will cease in some or all of the cylinders if a ground connection occurs through a break in the insulation of the cables or from other cause.

To guard against this, the insulation of the wires must be complete and the terminals properly protected.

Dry cells are always provided with a pasteboard covering over the zinc element, and it must be borne in mind that if this pasteboard covering becomes moistened, it will act as a conductor. If this condition exists in two adjacent cells, a short circuit will result. The most serious difficulty will be encountered when cells with moistened covers are used in a metal battery box. This will provide an absolute ground, and will render it impossible to run the engine on either the battery or on the magneto.

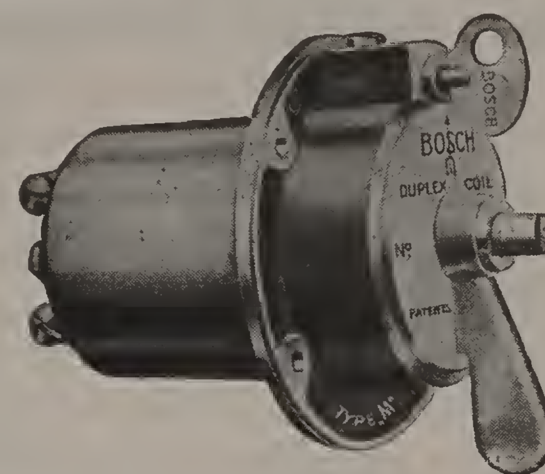
The greatest care must be exercised to prevent the grounding of the battery.

Furthermore, dry cells should be so arranged in the battery box that there will be no likelihood of their shifting from the vibration of the car or boat, in consequence of which the zinc terminals will come in contact either with each other or with the metal box. The best arrangement is to provide the box with compartments into which the cells can be fitted.

INSTALLING THE DUPLEX SYSTEM

The following points must be borne in mind in mounting the ignition system and in making the connections.

1. The timing range of the duplex magneto, the speed at which they must be driven with relation to the engine crank shaft, the manner of drive, also the procedure in connecting the high tension cables from the magneto to the spark plugs in the cylinders, are all exactly the same as with the corresponding independent Bosch types.



The Bosch Duplex Coil, Figure 17

2. The battery connection and the connections between the battery, coil and magneto, must be in strict accordance with the wiring diagrams. With the exception of the cables to the spark plugs, all connections are low tension and the wiring should be made accordingly.
3. Great care must be taken to prevent the possibilty of the battery becoming grounded, either through improperly protected terminals, faulty insulation, contact among the dry cells themselves or contact between the dry cells and the metal battery box, due to moist or injured cell coverings.

To avoid the possibility of trouble, all cables for connections to the magneto and coil should be provided with Bosch Loop Terminals, which will protect the cable against breakage and also prevent the straying of loose cable strands. Cables provided with large metallic terminals, or used without terminals, will usually lead to trouble through short-circuiting and breakage.

Setting the Magneto: The magneto is to be secured to the base provided for it with the driving gear or coupling loose on the armature shaft. The engine should then be cranked until one of the pistons, preferably that of Number 1 cylinder, is at top dead center of the compression stroke, and should be maintained thus until completion of the installation.

The timing arm attached to the interrupter housing is to be placed in the full retard position, which is accomplished by moving it as far as possible in the direction in which the armature will be driven.

The cover of the interrupter housing is to be removed to permit inspection of the interrupter, and the armature is to be rotated in the direction in which it will be driven, until it is seen that the magneto interrupter screws are in the act of separating. The armature is to be held firmly in that position while the driving gear or coupling is set tightly on the armature shaft. The cover of the interrupter housing is then to be returned to position and the setting is complete.

The setting above described will render it possible to operate the engine, but the engine characteristics may make it possible that a slightly different setting will give somewhat better results. It is frequently the case that with the interrupter breaking in the full retard position when the crank shaft is about 5° over top dead center of the compression stroke, more satisfactory results will be obtained.

The changes made in determining the best setting should be very slight, for a change of more than a few degrees may have a marked effect on engine operation. Where specific instructions for magneto setting are given by the engine manufacturers, it is recommended that such instructions be followed in preference to those herein given.

CARE AND MAINTENANCE

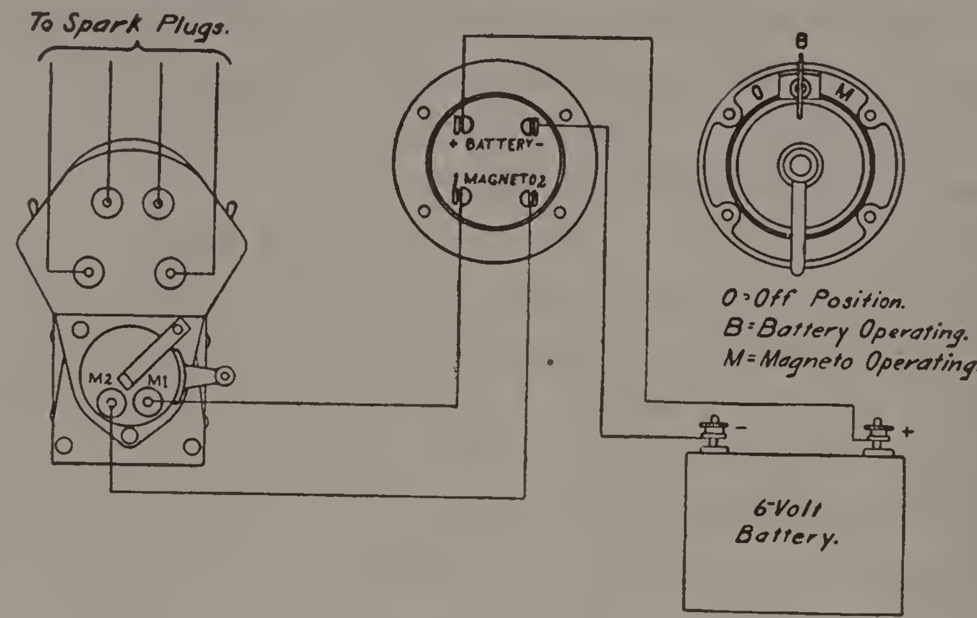
Duplex Coil: The design and construction of the coil are such that there is very little which can possibly get out of order and, therefore, under ordinary conditions this unit requires practically no attention.

If at any time the action of the ignition system becomes irregular, and it is suspected that the fault is in the coil, the coil body may be removed from the housing by withdrawing the holding screw located at the "B" position in the supporting flange; the switch should then be unlocked and the coil cover given a quarter turn. This will release the cover, and the coil body may be withdrawn to permit inspection of the switch contacts both of the coil and the stationary switch plate. It may be that the spring contacts are ben or otherwise in bad condition.

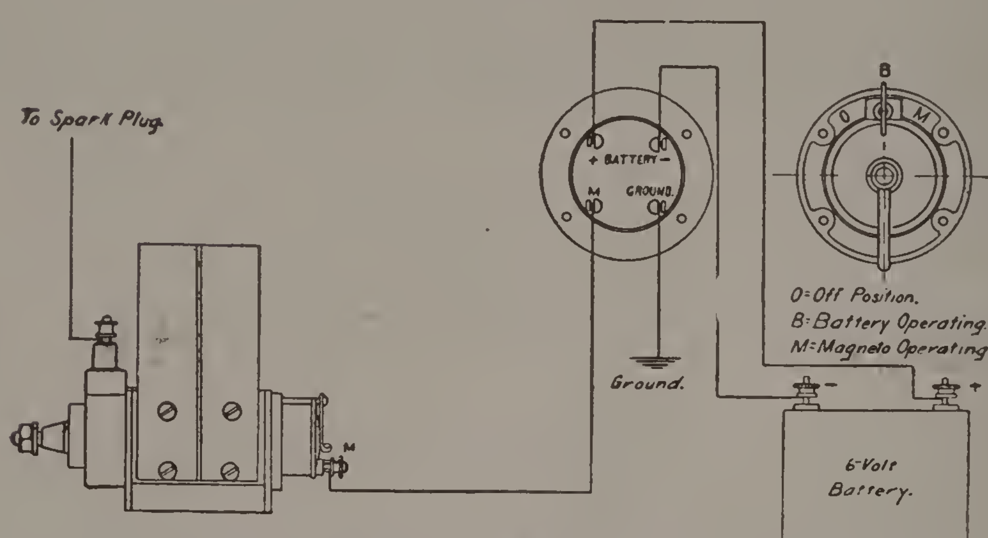
The withdrawing of the coil body should never be done unless it is certain that the fault is due to the coil; its handling under such conditions should be performed with extreme care. No work should be done on the coil in the way of withdrawing screws, etc., and if the inspection does not disclose the fault, the coil should be returned to its housing and the whole returned to the Bosch Magneto Company or its nearest official representative.

Duplex Magneto: The instructions for care and maintenance of duplex magnetos, as well as for locating and remedying troubles, are the same as for the corresponding independent Bosch magneto types.

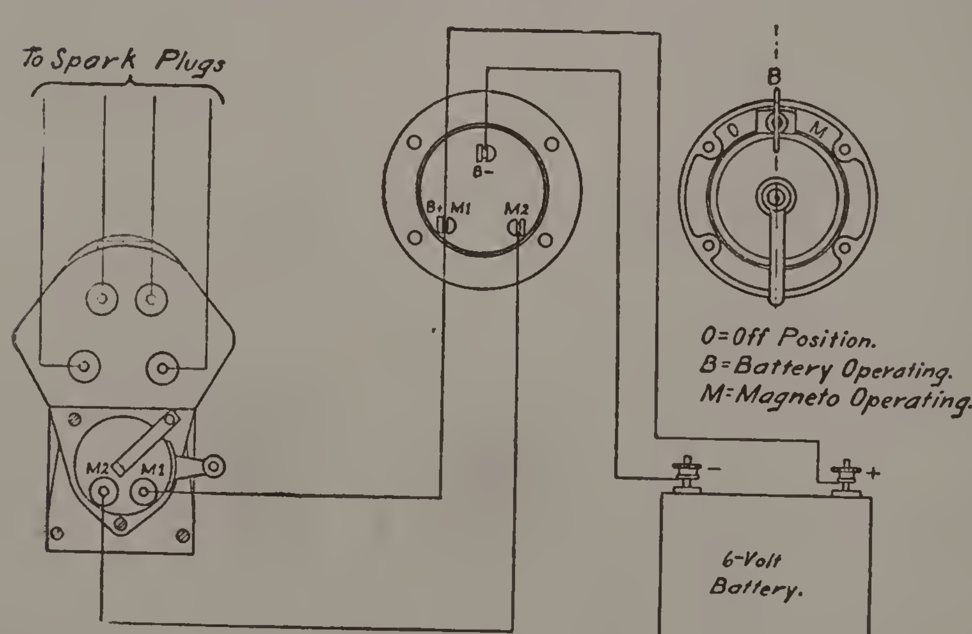
Wiring Diagrams for the Bosch Duplex Ignition System



1. For Types "La2" and "Ma" Coils Figure 18.



2. For Types "La1" and Ma1" Coils Figure 19.



3. For Type "M" Coil Figure 20.

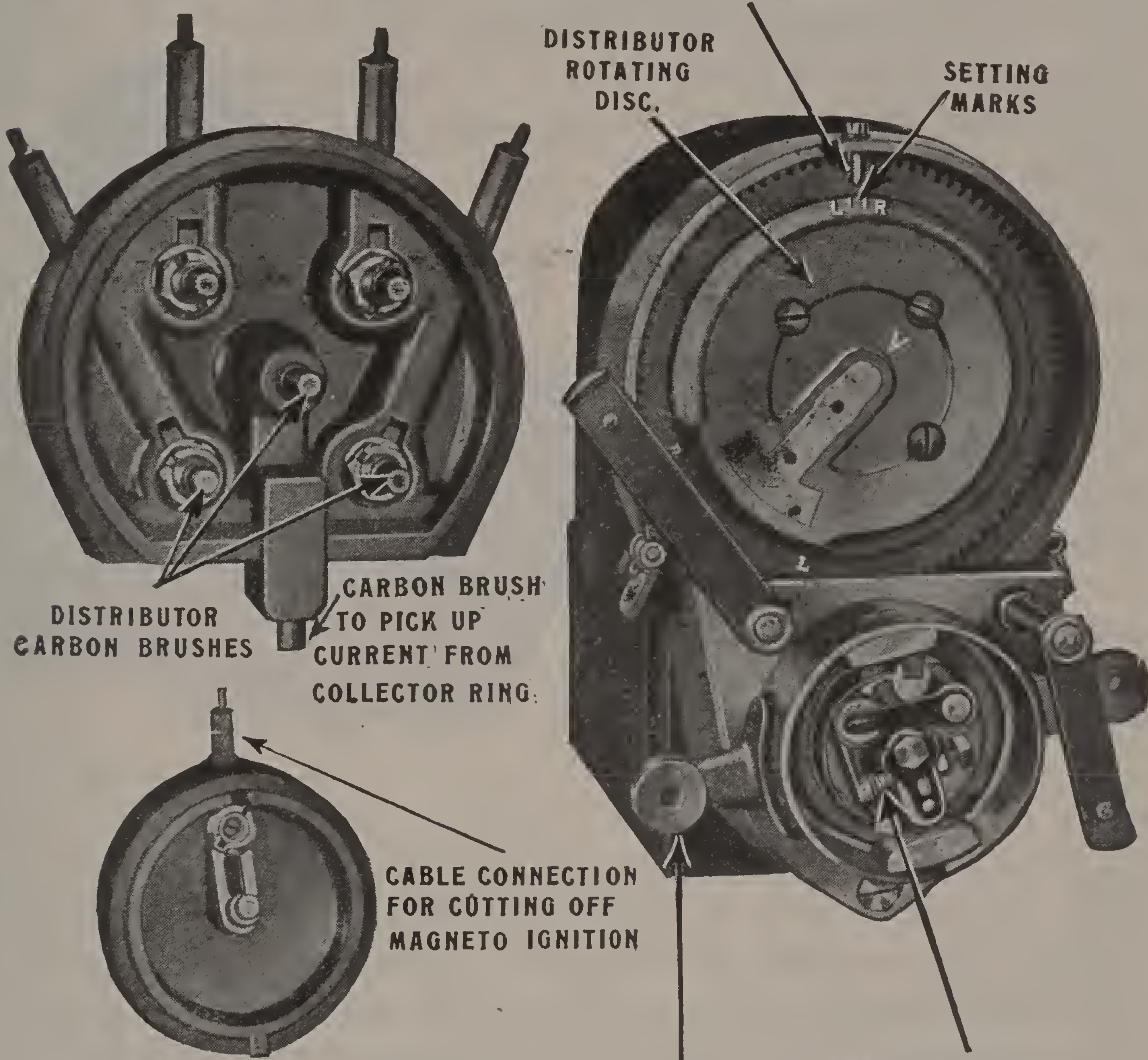


Figure 21.

THE "G4-II EDITION" MAGNETO

Since this booklet is intended as an instruction book, no general description will be attempted beyond a brief explanation of the fundamental differences between the "G4-I Edit." and the "G4-II Edit.," to which latter this booklet applies. There are only two essential points of divergence, **neither of which affects the interchangability of the magnetos on the motor.**

Difference Between I and II Edition

The flat spring style of contact breaker used in the I-Edit. is replaced by a "rocker-arm" type, of slightly more rugged construction, in which the arm is actuated by riding over two flat steel cams, as can be seen in figure 21.

The other chief difference is in the design of the frame, or housing, which is of a new unit-cast construction, whereas the I-Edit. housing was built up of several parts screwed together. This unit-casting has the advantage that it is extremely rigid, thus positively eliminating all danger of loosened screws or end plates, etc., due to vibration or accidental twisting. Another benefit resulting from the absence of any joints is that it forms an absolutely water, oil, and dust tight protection for the vital elements, such as the winding and the condenser. Further, since it can now be bored out and machined all in one piece, and because of its rigidity, it is possible to hold more closely the running clearance between the armature and the poles of the magnets. This tends to give increased magnetic efficiency and, as a result, a much hotter spark.

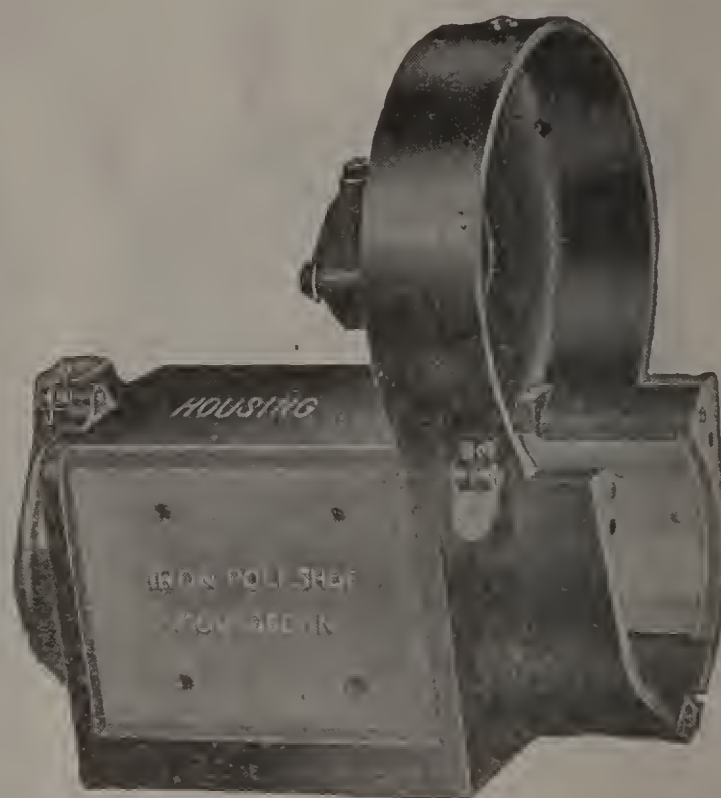


Figure 22.

INSTALLATION

Magnetos are made to turn in either direction, and **care must be taken when ordering to state the correct rotation as seen from the driving end of the magneto.** If no definite information is given about the direction, it will be taken for granted that it is required clockwise, and the apparatus corresponding will be sent. The direction of rotation is marked with an arrow on the driving end. The drive must be positive, either by gears or chain. We decidedly recommend the use of the former in conjunction with a flexible coupling.

As two sparks occur in each revolution of the armature, the magneto must rotate as follows:

FOUR-CYCLE MOTORS. 4 cylinders—engine speed.

FOUR-CYCLE MOTORS. 8 cylinders—twice engine speed.

Timing the Magneto to the Motor—For Variable Spark

As the spark occurs when the primary circuit is broken by the opening of the platinum contacts on the breaker mechanism, it is necessary that the magneto will be so timed that at full retard position of the timing lever body the platinum contacts just begin to open when the respective piston of the motor has reached its highest point on the compression stroke. Turn motor by hand until piston of Number 1 cylinder is on dead center (firing point), remove the distributor plate from the magneto and turn the driving shaft until the setting mark on the distributor disc is in line with the setting screw as shown in figure 21. (For magneto rotating clockwise, use setting mark "R", and for anti-clockwise, use mark "L".) With the armature in this position, the platinum contacts are just opening, and the metal insert of the distributor disc is in connection with carbon for number 1 cylinder. The driving medium must now be fixed to the armature shaft without disturbing the position of the latter, and the cables connected to the spark plugs.

Timing the Magneto to the Motor—For Fixed Spark

In fixed ignition where the timing of the spark never varies, the object in view is to find a medium between the occurrence of the spark at full retard and full advance. It must not occur too late, as the motor will overheat and lose power, nor occur too early ,as the motor will kick back when cranking, or knock when laboring hard, such as hill climbing, etc. It is evident, therefore, that the spark must occur before the piston reaches dead center, and as some motors, for certain reasons, can stand more advance than others, there is no predetermined rule for the timing which would apply to all motors. It is, therefore, advisable to find out from the maker of the motor at what distance before the piston reaches dead center the spark should occur for fixed ignition.

With piston in position as mentioned above, the setting mark on the distributor should then be brought in line with the setting screw, and the driving medium (either coupling or gear) should be fixed in this position.

MAINTENANCE

It is impossible to place too much importance on the **judicious** oiling of the magneto. Hence, remember that the following instructions are of vital importance to the efficiency of the instrument in general and to the life of the contact points in particular.

Oiling

For lubricating the ball bearing at the breaker end, two oil wells with hinged covers are provided, one on each side of the housing, just back of the timing arm. Both of these lead to the same bearing and only the one which is most accessible should be used. This well **should positively not receive more than one drop** every 1,000 miles or so.

At the driving end two oil holes will be found. The larger one leads to the plain bearing carrying the distributor shaft and should be given about 15 drops every 1,000 miles. The smaller hole leads to the ball bearing at the driving end and should receive 4 or 5 drops in the same distance.

Good **clean** cylinder oil will do, but **do not over-oil** if you wish to avoid trouble.

Cleaning

The contact points of the breaker mechanism and, in fact, the entire breaker itself, should be thoroughly cleaned with gasoline as often as they accumulate even a trace of oil or dirt. The distributor rotating disc, the carbon brushes, and the collector ring should likewise be cleaned occasionally with a soft cloth moistened with gasoline. For obvious reasons all the parts should be allowed to dry before attempting to run.

Cables

In order to obtain the best results the cables should be at once replaced if they show signs of cracking or wearing.

Contact Points

The contact points should be inspected occasionally to see that they are clean and flat, and also that the maximum gap between the points is according to the gauge on the special adjusting wrench, or about 0.012″ to 0.014.″

After a year of normal service it is advisable to carry in reserve a few carbon brushes for the distributor plate, as well as an extra set of contact points.

LOCATING TROUBLES AND REMEDYING THEM

If the motor misfires or refuses to start, and the ignition is suspected, it should be found out first whether the trouble lies in the magneto or in the spark plugs. The latter should be examined first, as they are the most frequent cause of trouble.

Spark Plugs

If the missing is in one cylinder only or in different cylinders, the corresponding spark plugs should be examined to see that the gap is not too large. This gap between the electrodes should be between one sixty-fourth and one thirty-secondth of an inch. In no case should it exceed one thirty-secondth of an inch. On the other hand, a gap less than one sixty-fourth of an inch is liable to cause missing at low throttle opening. Also, the spark plug may be short-circuited through carbon or oil, or the insulation may be cracked. Cleaning with gasoline or replacing is the remedy.

Burned or Pitted Contact Points

Clean same with gasoline until the contact surface appears quite white, or, if pitted, use a fine file—but very carefully—so that the surfaces remain square to each other. For this purpose a special file may be procured from us at nominal cost. The correct gap of the contact points is 12/1000 (.3 m/m). As these contacts wear away in time, they should be regulated by giving the adjustable screw a forward turn, care being taken to **securely tighten the lock nut.** This can be accomplished, without removing the timing lever or breaker mechanism, by means of the combination wrench which is furnished with each magneto and which includes a gauge for the regulation of the gap between the contacts. It is very essential that this gauge be used, as the gap is very deceptive when judged by eye alone.

If the contact riveted to the rocker-arm, or that of the adjustable screw should be worn down entirely, it would necessitate a change of either or both. When the adjustable screw is replaced or adjusted, care must be taken that the lock nut is securely tightened in place.

Wiring The wiring should be carefully examined and checked in accordance with the firing order of the motor. If cables are cracked or chafed, they should be replaced. All connections must be kept clean and tight.

If, after following these instructions, the motor still refuses to start, the magneto should then be tested by removing the distributor plate and resting a screw-driver on the gear casing, holding same about ⅛″ from the collector ring. Then, if upon rotating the armature, a spark jumps across the ⅛″ gap, it shows that the trouble does not lie in the magneto, but in some other part of the motor, possibly the carburetor.

Testing Magneto

A re-magnetization of the magnets will only be necessary if these have been taken away from the apparatus and allowed to remain a long time without both ends of the magnets being connected with a piece of soft iron. The same thing occurs if the armature is taken out of the pole pieces without a conducting rod of iron being laid across both poles. This piece must remain on the poles until the armature is again placed between the pole pieces. Often the magnets, after being taken down, are put back with one reversed and in this way the magnetic power is neutralized. To prevent this mistake, all our magnets are now marked, the north pole being designated by the letter "N" stamped in the magnet. When replacing magnets, care should be taken to place the same poles on the same side.

Magnets

EISEMANN HIGH TENSION DUAL SYSTEM

The primary purpose of this system is to give two sources of ignition, magneto and battery, using one distributor and one set of spark plugs. The arrangement consists essentially of a direct high-

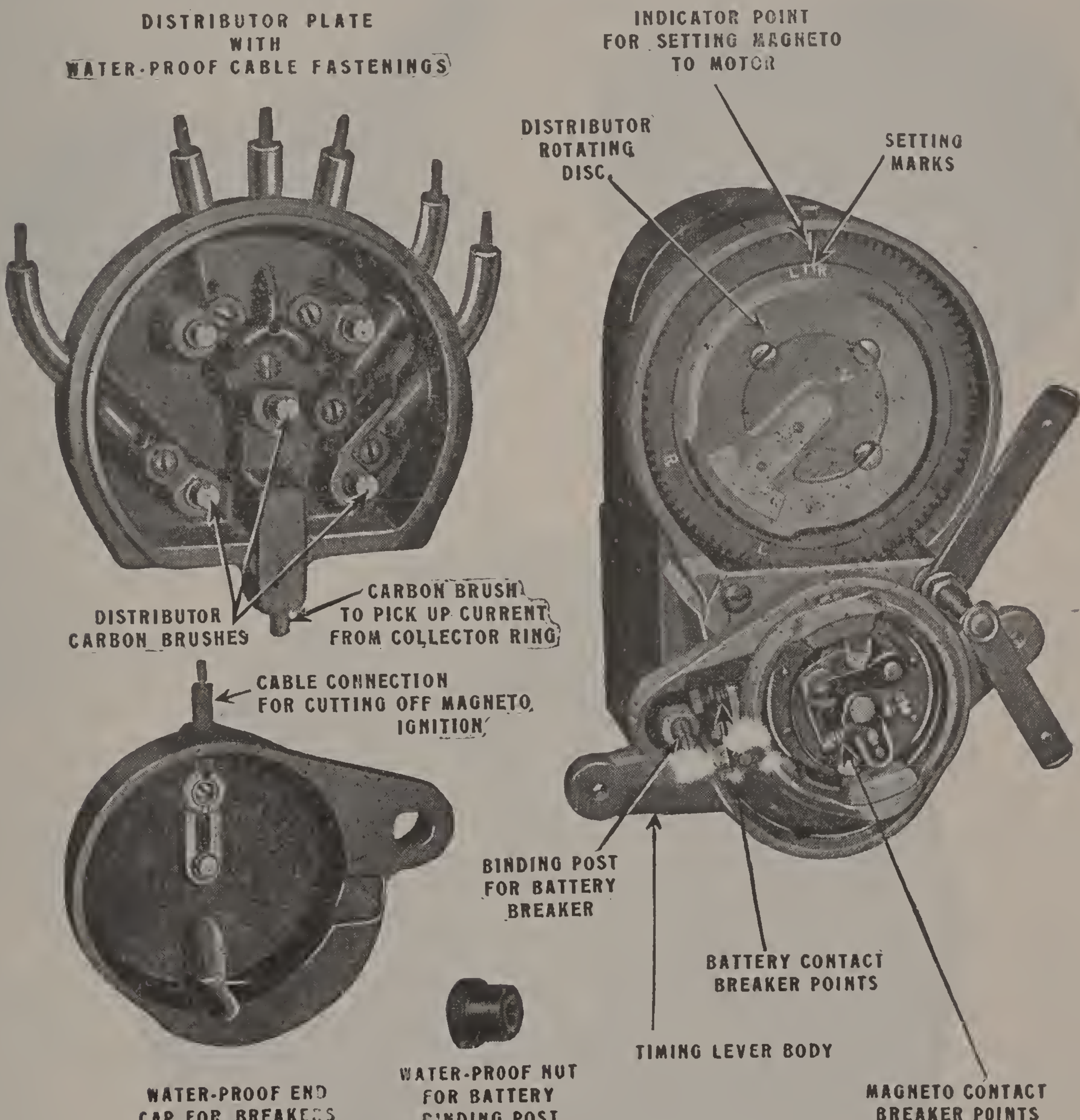


Figure 23.

tension magneto, used in conjunction with a combined transformer coil and switch which can be mounted on the dash. This transformer coil is used only in connection with the battery, whereas the switch is used in common with both the battery and the magneto.

The Eisemann Type "GR4" magneto, as seen from the above illustration of its principal parts, is practically the same as the popular "G4" independent instrument with two main exceptions,—the timing arm is equipped with an extra, separate contact breaker

Figure 24. Type "DC" Coil

Figure 25. Type "DCR" Coil

Figure 26.

for the battery current and the distributor is modified to permit of its electrical separation from the magneto armature when distributing the battery spark.

This magneto may be used with equally good results with either of the styles of Eisemann dash coils, Type "D. C." (figure 24) or Type "D. C. R." (figure 25). They differ only in the arrangment for starting "on the spark"—the "D. C.." having a push button giving a single spark, provided the motor happens to stand with the battery breaker open, whereas the "D. C. R." has a mechanical ratchet device (see figure 25) delivering a shower of sparks regardless of the crank position of the motor.

Rapid twisting, back and forth, of the starting handle on the front of the coil causes the toothed ratchet in the center, by acting against the fiber roller "A," to oscillate the level "B", which, in turn, makes contact alternately at "C" and "D," giving a rapid sequence of sparks at the plugs.

It might not be amiss to say a few words explaining the fundamental differences between the "GR4-I Edition" and the "GR4-II Edition," to which this booklet applies. There are only two essential points of difference.

The flat spring style of breaker used in the I-Edition is replaced by a rocker-arm type, in which the arm is actuated by riding over the two flat steel cams, as can be seen in figure 25, no change whatever being made in the battery breaker.

The other chief difference is in the design of the main frame, or housing, which is of a new, unit-cast construction in the II-Edition, whereas the I-Edition was built up of several parts. This unit casting has, amongst other, the advantage of being extremely rigid, thus positively eliminating the former possibility of loosened screws or endplates, due to vibration or accidental twisting. Another benefit resulting from the absence of any joints is that it makes an absolutely water, oil, and dust tight protection for the vital elements, such as the winding and the condenser. Further, since it can now be machined and bored out all in one piece, and because of its rigidity, it is now possible to hold more closely—and even reduce—the running clearance between the armature and the pole shoes of the magnets. This tends to give greatly increased magnetic efficiency and, as a result, a much hotter spark.

Commencing with the II-Edition, the "GR4" will have the improved form of distributor plate in which, by glancing at figure 23, will be seen that the connection screws for fastening the cables are completely exposed to view alongside the respective carbon brush holders. This accessible location, together with the use of a screw with a large head, makes it a relatively easy matter to handle the fastening of the cables. Incidentally, this improved form of plate can be used on the I-Edition also.

INSTALLATION

Eisemann Magnetos are produced to turn in either direction, clockwise or anti-clockwise, **looking from the driven end.** The direction of rotation is plainly indicated with an arrow on the shaft end. The drive must be positive, either by gears or by chains. We decidedly recommend the former in conjunction with a flexible coupling. As two sparks occur in each revolution of the armature, the magneto must rotate at engine speed, for four-cylinder, four-cycle motors.

Direction of Rotation and Speed

As the spark occurs when the primary circuit is broken by the opening of the platinum contacts on the breaker mechanism, it is necessary that the magneto will be so timed that at full retard position of the timing lever body the platinum contacts just begin to open when the respective piston of the motor has reached its highest point on the compression stroke. Turn motor by hand until piston of No. 1 cylinder is on dead center (firing point), remove the distributor plate from the magneto and turn the driving shaft until the setting mark on the distributor disc is in line with the setting screw as shown in figure 23. (For magneto rotating clockwise, use setting mark "R," and for anti-clockwise use mark "L.") With the armature in this position, the platinum contacts of the magneto breaker are just opening, and the metal insert of the distributor disc is in connection with carbon for Number 1 cylinder. The driving medium must now be fixed to the

Timing the Magneto to the Motor

armature shaft without disturbing the position of the latter, and the cables connected to the plugs (see also "Wiring").

It has been found advisable in practice to time the battery spark slightly later than that of the magneto itself. For this reason the battery on the Eisemann dual type instruments is permanently arranged to open 10° later than the magneto breaker, although subject to the same degree of advance and retard.

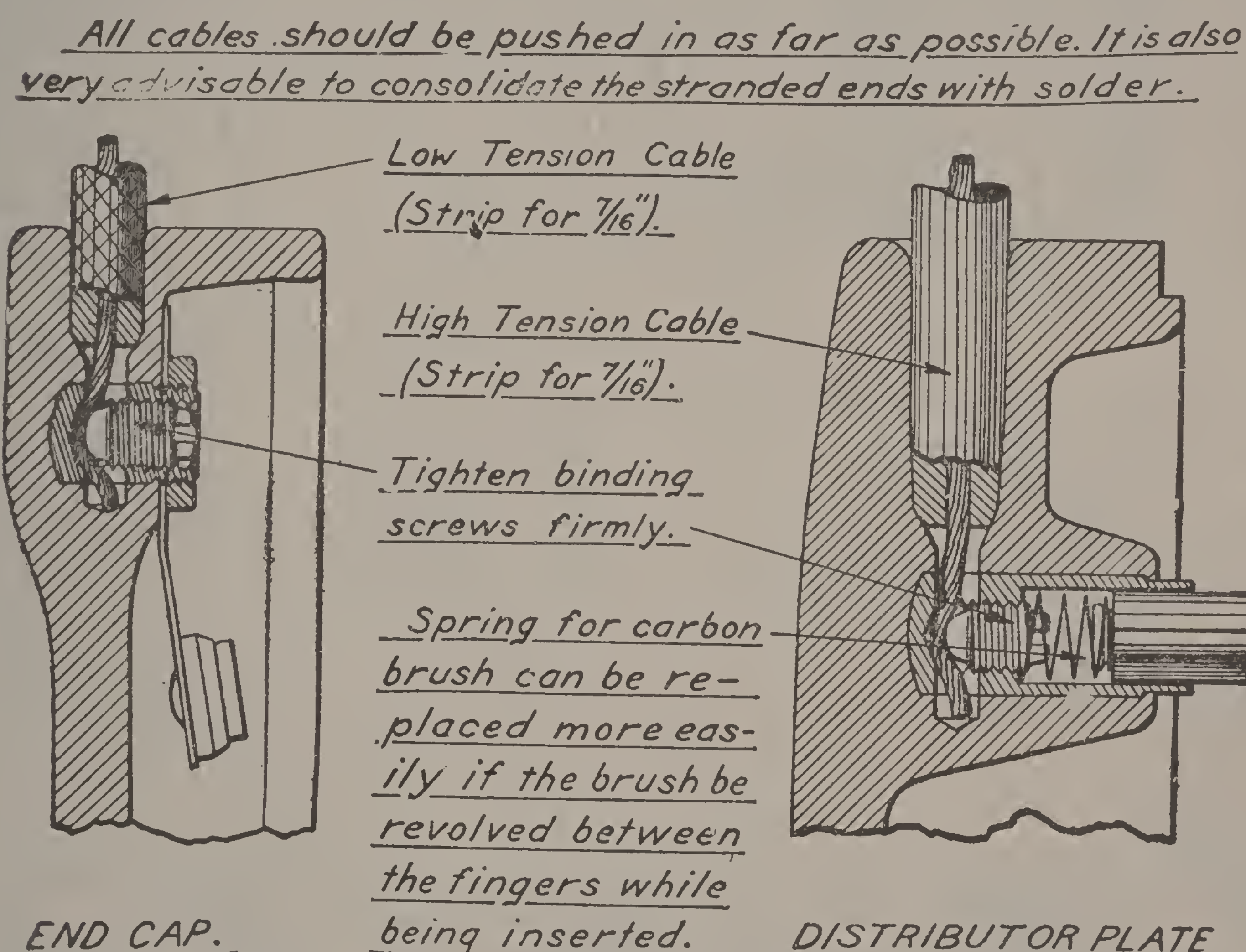
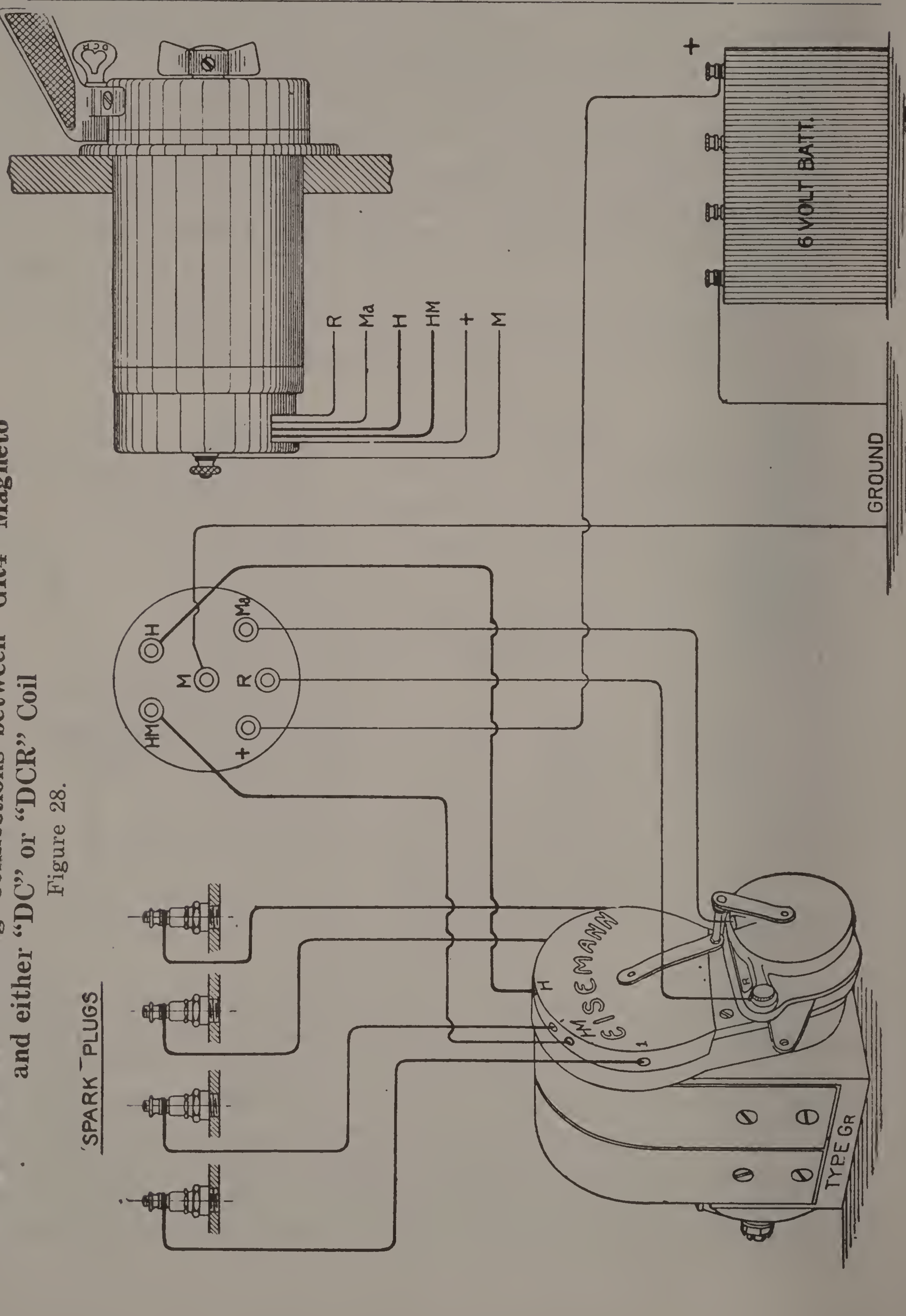


Figure 27.

Wiring

The attaching of the cables to the spark plugs **must be made in accordance with the firing order of the motor.** For connecting between coil and magneto, see figure 27. The proper fastening of the cables to the distributor plate and end cap is of very great importance, in order to prevent water or any other conductor making a short-circuit between the different connections. Figure 26 illustrates and explains how these cables should be attached. This internal method of attach-



Wiring Diagram Showing Connections between "GR4" Magneto and either "DC" or "DCR" Coil

Figure 28.

ing the cables to the distributor plate is another of our exclusive features, and makes a water-tight and solid connection.

Important—The connection screw with the round head used in the distributor plate must not be used for the end cup, as the large head will not clear the revolving breaker mechanism.

MAINTENANCE

It is imposible to place too much importance on the judicious oiling of the magneto. Hence, remember that the following instructions are of vital importance to the efficiency of the instrument in general and to the life of the contact points in particular.

Oiling

For lubricating the ball-bearing at the breaker end, two oil wells with hinged covers are provided, one on each side of the housing, just back of the timing arm. Both of these lead to the same bearing and only the one which is most accessible should be used. This well **should positively not receive more than one drop** every 1000 miles or so.

Under the hinged cover at the driving end two oil holes will be found. The larger one leads to the reservoir which feeds the plain bearing carrying the distributor shaft and should be given about 15 drops every 1000 miles. The smaller hole leads to the ball bearing at the driving end and should receive 4 or 5 drops in the same distance.

Good, **clean** cylinder oil will do for all the oil wells, but **do not over-oil** if you wish to avoid trouble.

Cleaning

The contact points of both the magneto and battery breakers and, in fact, the entire breaker itself, should be thoroughly cleaned with gasoline as often as they accumulate even a trace of oil or dirt. The distributor rotating disc, the carbon brushes and the collector ring should likewise be cleaned occasionally with a cloth moistened with gasoline. For obvious reasons all the parts should be allowed to dry before attempting to run.

Cables

In order to obtain the best results, the cables should be at once replaced if they show signs of cracking or undue wearing.

Points The contacts should be inspected occasionally to see that they are clean and flat, and also that the maximum gap between the points is according to the gauge on the special adjusting wrench, or about 0.012″ to 0.014″.

Batteries We recommend the use of storage batteries with our dual ignition and our coils are designed to operate on six volts.

Spare Parts A list of spare parts and illustrations of same are shown on pages 10 to 14. After a year of normal service, it is advisable to carry in reserve a few carbon brushes for the distributor plate, as well as a contact breaker rocker-arm and an adjustable screw.

LOCATING TROUBLES AND REMEDYING THEM

If the motor misfires or refuses to start, and the ignition is suspected, it should be found out first whether the trouble lies in the magneto, the coil, or in the spark plugs. The latter should be examined first, as they are the most frequent cause of trouble.

Spark Plugs If the missing is in one cylinder only or in different cylinders, the corresponding spark plugs should be examined to see that the gap is not too large. This gap between the electrodes should be between one sixty-fourth and one thirty-secondth of an inch. In no case should it exceed one thirty-secondth of an inch. On the other hand, a gap less than one sixty-fourth of an inch is liable to cause missing at low throttle opening. Also the spark plug may be short-circuited through carbon or oil, or the insulation may be cracked. Cleaning with gasoline or replacing is the remedy.

Wiring The wiring should be carefully examined and checked in accordance with the firing order of the motor. If cables are cracked or chafed, they should be replaced. All connections must be kept clean and tight.

Clean same with gasoline until the contact surface appears quite white, or if pitted use a fine file—but very carefully—so that the surfaces remain square to each other. For this purpose a special file may be procured from us at nominal cost. The correct gap of the contact points is 12/1000″ (.3 m/m) for both magneto and battery breakers. As these contacts wear away in time, they should be regulated by giving the adjustable screw a forward turn, care being taken to **securely tighten the lock nut.** This can be accomplished, without removing the timing lever or breaker mechanism, by means of the combination wrench which is furnished with each magneto and which includes a gauge for the regulation of the gap between the contacts. It is very essential that this gauge be used as the gap is very deceptive when judged by the eye alone.

Contact Points; Burned or Pitted

If the contact riveted to the rocker-arm, or that of the adjustable screw should be worn down entirely, it would necessitate a change of either or both. When the adjustable screw is replaced or adjusted, care must be taken that the lock nut is securely tightened in place.

Testing Magneto

If after following these instructions the motor still refuses to start, the magneto should then be tested by removing the distributor plate and resting a screw-driver on the gear casing, holding same about 1/8″ from the collector ring. Then, if upon cranking the motor, a spark jumps across 1/8″ gap, it shows that the trouble does not lie in the magneto, but in some other part, possibly the coil or the carburetor.

The Coil

If the cables have all been checked up according to the wiring diagram and firing order, and if the system still refuses to work, although the magneto itself proves to be all right from the previous test, the trouble may lie in the switch mechanism of the coil. The design and construction of the coil, however, is such that it rarely gives trouble.

Running Without Coil

If, for the above reasons or any other, it is desired to run the motor without the coil, it may be accomplished as follows: Disconnect all wires leading from magneto to coil. Connect together the cables marked "H" and "HM", on the distributor plate, thus making a direct path for the high-tension current from the collector ring to distributor. The instrument can then operate as an independent magneto. A wire may be brought up from the "Ma" connection on the end cap, to the dash and simply touched to any grounded metallic part of the car when it is desired to stop the motor.

PRINCIPLE OF THE DIXIE MAGNETO

In all electric generating machines the current is produced by cutting lines of magnetic force by conductors. This may be accomplished in various ways, but the first two laws of electricity are basic for all designs. They are as follows:

(1) An electromotive force is produced when lines of magnetic force are cut by conductors. The effect produced is the same whether a conductor is moved so as to cut the lines of magnetic force, or the lines of force are caused to cut a stationary conductor.

(2) The electromotive force produced is proportional to the rate at which the magnetic lines are cut.

RELATION OF MAGNETO SPEED TO ENGINE SPEED

The speed of the magneto is always spoken of in terms of engine speed and the engine speed is considered as a unit for sake of convenience.

The magneto speed is found by dividing the number of sparks required by the engine per revolution by the number of sparks which the magneto will deliver per revolution of its drive shaft.

DIXIE magnetos will deliver one, two, or four sparks per revolution of the drive shaft.

The speed at which the magneto should be driven on 4 stroke cycle engines is found in the following Table:

SPEED TABLE

Model	No. of Cylinders	Degrees Advance	Sparks per Rev. of Magneto	Mag. Speed to Engine Speed
M-1	1	23	1	½
M-2	2	23	2	½
MRI-2	9	Fixed	2	2¼
44	4	40	2	1
46	4	40	2	1
441	4	40	2	1
442	2	40	1	1
462	2	40	1	1
481	4	30	2	1
63	3	40	1	1½
64	6	40	2	1½
68	6	30	2	1½
612	6	30	2	1½
83	8	30	4	1
84	8	30	4	1
85	8	30	4	1
86	8	30	4	1
88	8	30	4	1
800	8	Fixed	4	1
825	8	Fixed	2	2
124	12	30	4	1½

RANGE OF SPARK ADVANCE

The number of degrees of advance effective on an engine is dependent on the speed of the magneto. Magnetos which run at engine speed have the same degree of advance effective on the engine as on the magneto. The advance effective on magnetos operating at other than engine speed is as follows:

For magnetos driven at 1½ times engine speed, the effective advance is 2-3 of the range of the magneto, and for magnetos driven at ½ engine speed is 2 times that of the magneto. DIXIE magnetos are made with different ranges of advance, suitable for engines of various types. The variation of the spark timing is accomplished by a lever, located on either side, or with double levers, one on each side.

SAFETY SPARK GAP

A safety spark gap is provided as a protection for the insulation of the winding and other parts in the secondary circuit. The voltage of the secondary current is proportional to the resistance which it has to overcome. If the magneto should be operated without one or more of the distributor wires connected, the safety gap provides a path for the high-tension current. The width of the safety gap should be from 5-16 inch to 3/8 inch, depending upon the compression in the engine. In engines where high compression exists, the safety gap should be set to 3/8 inch.

Under high compression, the sparks may fire across the safety gap instead of firing in the engine. Misfiring under such conditions can easily be remedied by opening the safety gap so that it will offer a greater resistance to the secondary current than the spark plug gap, under compression. Sparks should not be permitted to discharge across the safety gap for any great length of time.

When two independent magnetos with two sets of spark plugs are used and the high tension leads disconnected from one magneto it should be grounded so that the sparks will not discharge across the safety gap when the other magneto is in use.

THE DIXIE UNIDIRECTIONAL MAGNETO

This magneto has been developed for use on high compression engines. It is called the Unidirectional type because it produces sparks of only one polarity. The DIXIE principle has been retained, with a modification of some of the parts. It is manufactured in the following models:

For 4 cylinder engines	For 6 cylinder engines
Model 481	Model 68
	Model 612

In the 8 and 12 cylinder magnetos a field structure, rotor and cam are employed which produce four sparks per revolution of the magneto shaft, two of the sparks being of one polarity and two of the opposite polarity. In the Unidirectional type the same field structure and rotor are used with a cam of slightly different design, so that only two sparks are produced per revolution of magneto shaft, both being of the same polarity.

OILING

The bearings of the magneto are provided with oil cups. These cups should be filled twice with a good grade of light oil before running the magneto for the first time, and should be similarly oiled thereafter as follows:

Automobiles, every 1,000 miles.

Trucks, every 500 miles.

Aeroplanes, every 25 hours of operation.

Tractors, motor boats, and stationary engines, four drops of light oil every 20 hours of actual operation in the oil cup which is located on the top of the magneto just back of the distributor, and two drops of light oil every 20 hours of operation in the oil cup on the rear of the magneto.

Every possible precaution should be taken to prevent oil from getting on the platinum points, which will cause the magneto to operate unsatisfactorily, resulting in flashing at the contact points when running, and misfiring of the engine.

INSTRUCTIONS FOR INSTALLING

One of the pistons of the engine should be in the proper position for timing as given by the manufacturer of the engine.

Before placing the magneto on its support, care should be taken to see that there are no burrs around the holes in the support. The magneto should be set level on the support which carries it, and line up properly with the gear or coupling by which it is driven.

The driving shaft of the magneto should be rotated in the direction in which it will be driven until the distributor brush is in contact with the segment Number 1, of the distributor block.

The circuit breaker should be closely observed and when the platinum contacts are about to separate, the drive gear or coupling should be secured to the drive shaft of the magneto. Care should be taken not to alter the position of the magneto shaft when tightening the nut to secure the gear or coupling, after which the magneto should be secured to its support.

The screws securing the magneto to its support should be drawn up tight, without springing the support or straining the threads in the base of the magneto.

Where two magnetos are used on the same engine, one of them should be adjusted so that the point of firing conforms to the setting as given by the manufacturer of the engine. The other magneto should then be synchronized with the first one so that both magnetos will produce sparks at the same instant. This should be performed by means of adjustable couplings and not by the adjustment of the contact points or by shifting the breaker base.

SETTING THE DISTRIBUTOR

The distributor member is located on the distributor gear, meshing with the teeth of the pinion or driver in such a way that the contacts of the interrupter separate when the distributing brush is entirely on the segment with which it makes contact, when the timing lever is in the full advance position.

It should be remembered that the distributor rotates in the opposite direction to that of the magneto shaft. When the magneto has been secured to its support, remove the distributor to see which terminal of the block is making contact with the distributing brush in that position. Connect that terminal to the Number 1 cylinder and connect the remaining terminals around the distributor block in the direction of rotation of the distributor to the remaining cylinders of the engine in the proper sequence in which they should fire. The firing order of the magneto is stamped on the distributor block.

THE LATE TYPE BATTERY IGNITION SYSTEM.

The late type battery ignition system consists principally of a storage battery, high tension induction coil, distributor, interrupter points, and an ignition switch. It also has a condenser, and usually a resistance unit which is placed on one of the primary terminals of the coil. See Figure 29.

Tracing the current when the ignition switch is turned on, and the interrupter points are closed, the primary or battery circuit is completed; and the current immediately starts flowing from the positive terminal + and goes across the switch through the winding which is wound around the soft iron core of the coil to the insulated interrupter point to the grounded interrupter, and returns through the ground, which is the frame of the car to the negative side of the battery, thus completing the primary circuit. This current magnetizes the soft iron core, and sets up a magnetic field in the coil as indicated by the dotted lines. Now, this is all that the battery current ever does in any ignition system; and the instant the interrupter points are opened, the battery current stops flowing, and the magnetic field dies out very rapidly, which causes a current of electricity to flow in the secondary winding, which goes to the distributor and is distributed to the different spark plugs in the proper firing order. You will see in Figure 30 that the revolving segment is in contact with the terminal that leads to number I spark plug, and after the current jumps the gap at the plug it returns through the ground of the engine to the grounded end of the secondary winding from whence it started. You will note that in this system the primary and secondary windings are not in any way fastened together; and it is not necessary as the battery current never goes to the spark plugs on any system. All the battery current does is to magnetize the soft iron core of the coil. The secondary current originates or starts in the secondary winding, and the instant the interrupter points open, the magnetic field dies out which causes the electricity that was already in the wire, to start flowing, and as it starts from the secondary winding it will return back to the secondary winding.

The resistance unit on the top of the coil generally consists of a porcelain spool, which has a small coil spring made of German

A LATE TYPE SINGLE WIRE BATTERY SYSTEM

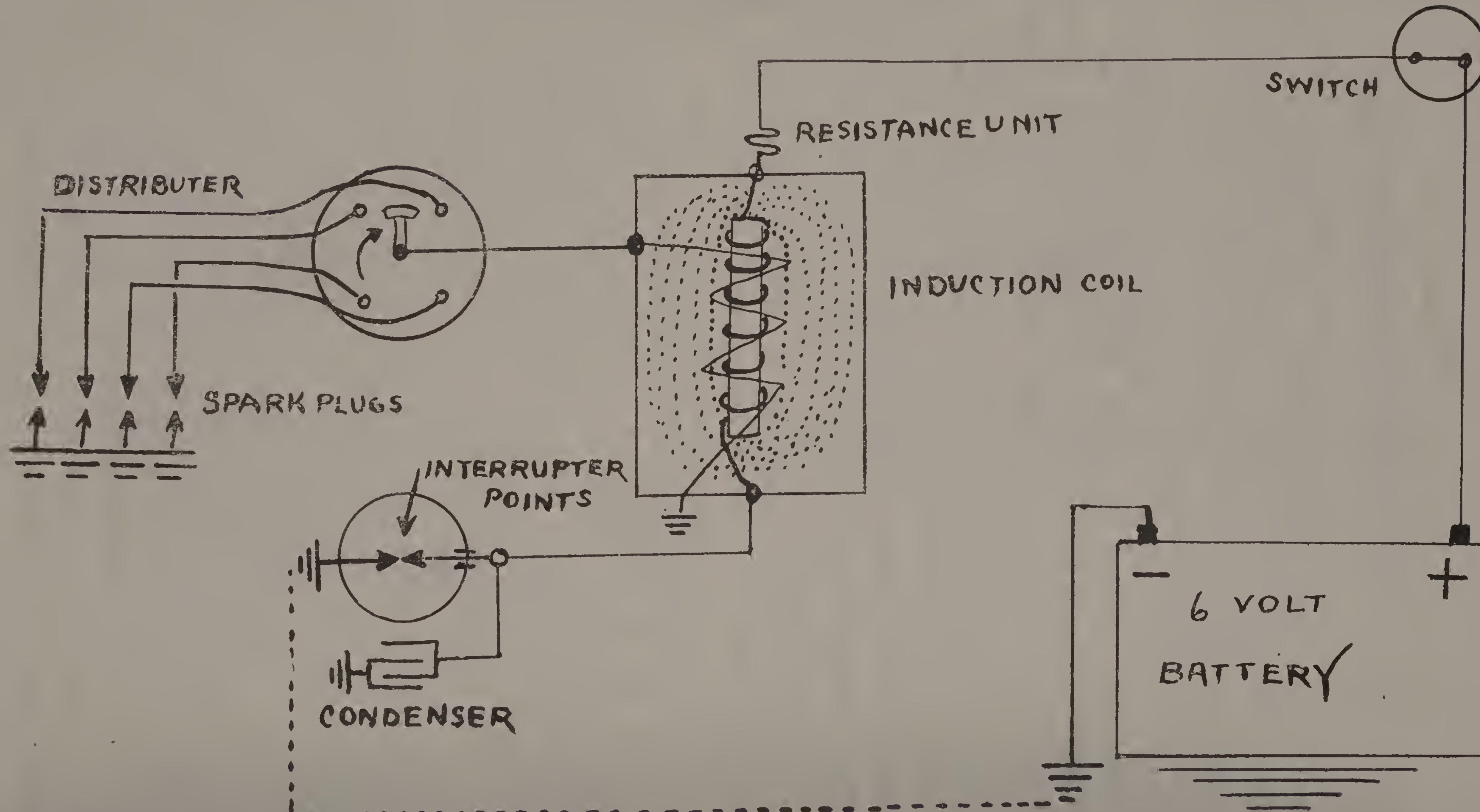


Figure 29.

A LATE TYPE SINGLE WIRE BATTERY SYSTEM

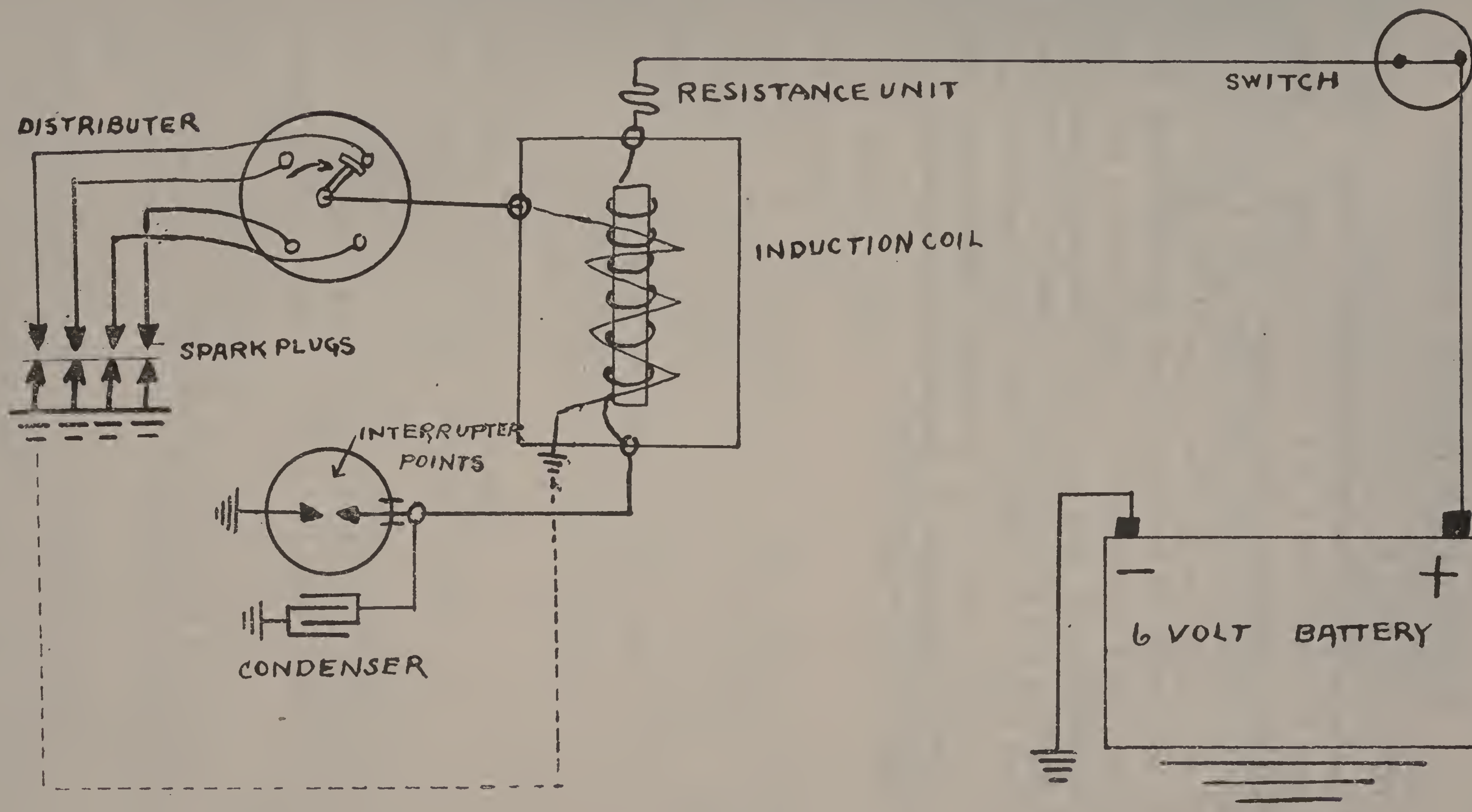


Figure 30.

silver wire surrounding it; and is for the purpose of regulating the flow of the battery current, and to keep the coil from being burned out, in case the switch was left on for any length of time. This resistance unit sometimes burns out, and in such case it would be necessary to replace it with a new one, or a substitute made of some other kind of wire, in order to get the system to operate.

The condenser can be grounded on one side, when one of the interrupter points is grounded, but where both of the interrupter points are insulated as they are in the "two wire system," it would be necessary to run an insulated wire from the condenser to the interrupter points, or connect it to a wire that does lead to the point. Condenser action has previously been treated. Note the position of the distributor segment with reference to the interrupter points in Figures 29 and 30.

QUESTIONS AND ANSWERS

Q---What is electricity?

A—No one knows any more than it is a form of energy which exists in every thing.

Q—Can it be insulated?

A—Yes.

Q—Why do we insulate it?

A—To make it go where we want it to go, and to keep it from going where we do not want it to go.

Q—What sets electricity in motion?

A--In the case of a storage battery, it is the chemical action. But with the generator it is set in motion by the armature cutting lines of magnetic force.

Q—What is magnetism?

A—Magnetism is a phenomenon of which there is very little known, and cannot be insulated. It can be created by winding an insulated wire around a soft iron or steel core, and then sending a current of electricity through the wire.

Q—What would happen if magnetism should cease to exist?

A—All of our dynamos would stop immediately.

Q—What metals are good conductors of magnetism?

A—Iron and steel.

Q—What metals are called non magnetic?

A—Brass, copper, aluminum, zink, and carbon.

Q—What is the law of induction?

A--Place a coil of wire in a magnetic field and cause the field to vary, and there will be a current induced in the wire, or by moving a coil of wire rapidly in a magnetic field will induce a current in the wire.

Q—What is an electro-magnet?

A—A soft iron core wound with an insulated wire, and is only a magnet during the time that a current is passing through the wire.

Q—What governs the strength of a magnetic field?

A—The strength of an electro-magnet is governed by the number of turns of wire, the strength of the current flowing, and the quality of the path through which the lines of force have to travel.

Q—How does a magneto generate a current?

A—By cutting lines of magnetic force.

Q—Can electricity be stored?

A—No. It is the electro motive force that is stored and not the electricity.

Q—What is electro motive force?

A—Electro-motive force is called the E M F or electrical energy, which is the same as voltage, or pressure.

Q—Do all dynamos generate an alternating current?

A—Yes, but the "so called" direct current generator by the use of a commutator, transforms the alternating in to direct current, before it leaves the generator.

Q—What is a permanent magnet?

A—A permanent magnet is a piece of hard steel which has been magnetized.

Q—What is the meaning of A. C. and D. C.?

A—A. C. stands for alternating current and D. C. for direct current.

Q—Why is an A. C. generator better for ignition purposes than a D. C.?

A—Because of the raid building up and dying out of the core of the armature, which is caused by the reversal of polarity every 180° which is each half revolution of the armature.

Q—Why is the high tension magneto the most efficient and reliable for ignition purposes?

A—Because of its simplicity, and few wires, and the condenser is close to the points and the core where it will do the best work, and it will not freeze up, as will a battery, and it will also give a more volumnous spark.

Q—How many windings on a low tension magneto?

A—One heavy insulated, winding, called the primary.

Q—What is the voltage of a low tension magneto?

A—From 6 to 30 volts depending on the speed at which it is driven.

Q—Why does a low tension magneto need a high tension coil in connection with it?

A—To step up the voltage, and make it sufficiently strong to jump the air gap at the spark plugs.

Q—What is the voltage of an H. T. coil?

A—From 12,000 to 25,000.

Q—What are lines of force?

A—They are invisible lines of magnetic force which flow from the north to the south pole of a magnet.

Q—What are the magnets of a magneto for?

A—To create a magnetic field.

Q—Will a magneto produce a good spark if the magnets are weak?

A—No.

Q—What are the pole shoes made of, and what are they for?

A—They are made of soft iron, and are for the purpose of filling the air gap between the magnets and the armature.

Q—Why is the base of a magneto made of a non-magnetic material?

A—To keep the lines of force from going through the bottom of the magneto, and cause them to go through the armature.

Q—What are the three types of armature, used on magnetos?

A—Shuttle, inductor, and rotor.

Q—Why is it necessary to have the core of A. C. generator laminated?

A—To reduce eddy current, and give a greater surface to the flow of the lines of force.

Q—What is a luminated core?

A—A laminated core is made of sheets of soft iron, or sometimes a bundle of soft iron wire, insulated from each other with a special varnish.

Q—What makes a magneto generate an alternating current?

A—A magneto generates an alternating current, for the reason that the armature is constantly changing its position in the magnetic field. That is, the lines of force flow through the armature in a different direction every 180 degrees.

Q—Of what does the primary winding consist?

A—The primary winding consists of a few layers of coarse insuated wire, and on a magneto, one end is grounded to the core of the armature.

Q—Of what does the secondary winding consist?

A—The secondary winding consists of several thousand turns of very fine insulated wire; it is wound over the primary.

Q—How many current impulses will a shuttle type armature produce in one revolution?

A—A magneto with a shuttle armature will not produce over two current impulses in one revolution.

Q—How many current impulses will an inductor type armature produce in one revolution?

A—A magneto with an inductor armature can be made to produce four current impulses to each revolution, by using a four cornered cam, which will open the breaker points four times to each revolution.

Q—What are the interrupter points for?

A—To make and break the primary circuit, which causes the magnetic field to build up or die out at the time a spark is needed in the cylinder.

Q—What material are the interrupter points usually made of?

A—Platinum or Tungsten.

Q—What is the proper adjustment of the interrupter points?

A—From 12 to 17 thousandths on a high tension, and from 25 to 30 thousandths on a low tension magneto.

Q—How can the interrupter points be trued up?

A—With a platinum file.

Q—What will happen if the points do not open the proper distance?

A—The motor will miss fire and may stop entirely.

Q—What is an indication of a poor condenser?

A—An excessive amount of sparking at the interrupter points.

Q—What is a condenser made of?

A—Tinfoil and is insulated with paraffined paper or mica.

Q—Where is a condenser located?

A—It may be located any place in the ignition system, so long as it is connected across the interrupter points.

Q—How can a condenser be tested?

A—With a 110 volt lighting system, either D. C. or A. C.

Q—In what circuit is the condenser placed?

A—It is always placed in the primary circuit.

Q—What is a distributor for?

A—It is a revolvong switch, and its function is to distribute the H. T. current to the spark plugs in their proper firing order.

Q—From which end of the magneto is the direction of rotation determined?

A—The driven end.

Q—What is meant by clockwise?

A—To travel in a right hand rotation, the same as the hands of a clock.

Q—What is meant by anti-clockwise?

A—To travel in a left hand rotation, opposite to the hands of a clock.

Q—What is meant by advance and retard?

A—To move the breaker box against the direction of rotation is advance, which causes the breaker points to open earlier. Retard is to move the breaker box with the direction of rotation, which causes the breaker points to open later.

Q—What is a high tension induction coil?

A—A coil with a primary and secondary winding.

Q—What is the voltage of an H. T. coil?

A—From 12,000 to 25,000.

Q—What is the voltage of a H. T. magneto?

A—From 10,000 to 20,000, depending on the speed that it is driven.

Q—How many windings has an H. T. magneto?

A—Two—primary and secondary.

Q—How is a H. T. magneto timed?

A—The same as a low tension magneto.

Q—What is meant by the magneto speeds?

A—It means how fast will the armature have to travel, with reference to the end speed.

Q—At what speed should a magneto with shuttle type armature be driven on a 4, 6, 8, and 12 cylinder engine?

A—Engine speed on a 4, once and a half times engine speed on a 6, twice engine speed on an 8, and three times engine speed on a 12.

Q—At what speed should a magneto with an inductor type armature be driven?

A—It is usually governed by the same rule as that of the shuttle type, but the K. W. high tension magneto is so designed that it can be driven at engine speed on a 4, or by using a four cornered cam it will produce 4 current impulses to each revolution, and can be used on an 8 cylinder motor and still be driven at engine speed.

Q—At what speed should a rotor type be driven?

A—See Dixie Magneto, page 73.

Other books on Electric Starters and Generators, covering the entire electrical equipment of the automobile now in course of preparation. For information write to Cedric S. Webster, Box 144, Independence, Missouri.